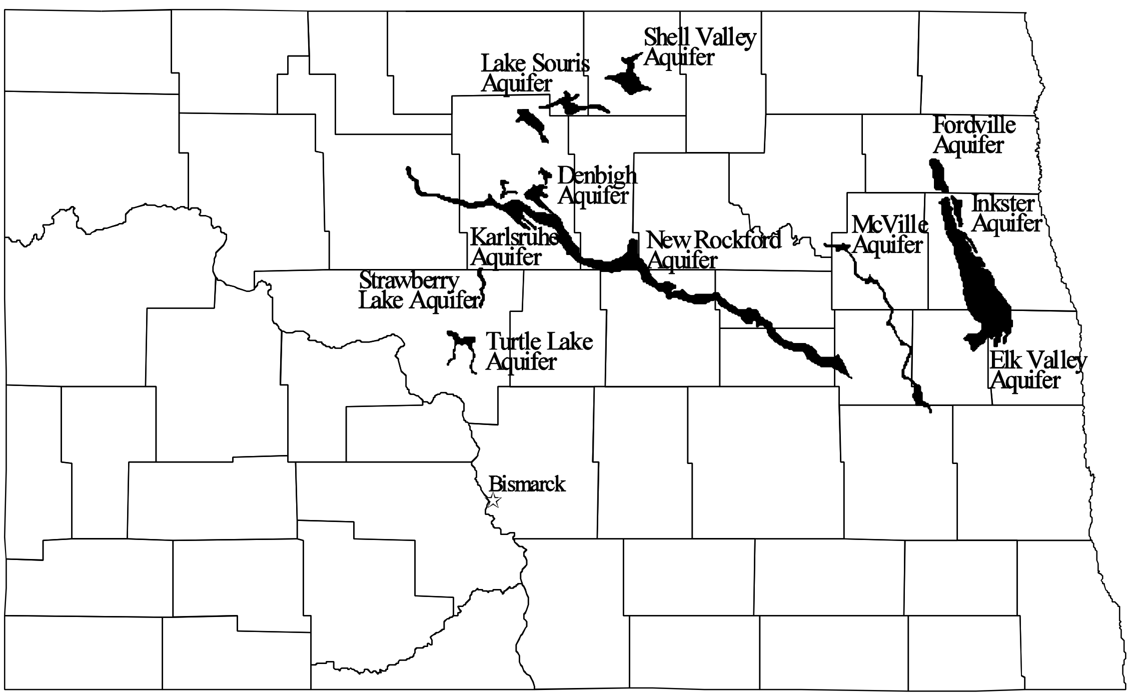
North Dakota Groundwater Monitoring Program
1998 Report



North Dakota Department of Health
Division of Water Quality

North Dakota Groundwater Monitoring Program

1998 Report

Edward T. Schafer, Governor
Murray G. Sagsveen, State Health Officer

Prepared by
Norene Bartelson, Environmental Scientist
Gerard Goven, Environmental Scientist

North Dakota Department of Health
Division of Water Quality
1200 Missouri Ave.
Bismarck, N.D. 58506-5520
701.328.5210

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ABSTRACT

To determine the degree to which agricultural chemical contamination of groundwater is occurring in North Dakota, an aquifer monitoring program was developed by the North Dakota Department of Health (NDDoH), Division of Water Quality. In 1998, monitoring was conducted in 11 aquifers: the Denbigh, Elk Valley, Fordville, Inkster, Lake Souris and Shell Valley aquifers, which were initially sampled as part of the ambient groundwater monitoring program in 1993, and the Karlsruhe, McVille, New Rockford, Strawberry Lake and Turtle Lake aquifers, which were sampled for the first time as part of this program.

All 11 aquifers consist primarily of sand and/or gravel and have fairly shallow water tables; several increasingly are being used for irrigation. A total of 214 wells were sampled for general anion and cation chemistry, nitrate and nitrite, and 60 selected pesticides or degradation products. Nineteen wells, about 9 percent, contained detectable concentrations of pesticides in the initial samples. Follow-up samples were collected from 13 wells. Nine wells with initial pesticide detections did not exhibit pesticide detections in follow-up samples. Picloram was detected in four wells in both the initial and follow-up samples. The pesticide compounds detected by laboratory analysis were bentazon, 2,4-D, endrin, 3-hydroxycarbofuran, methomyl, picloram and triallate (Fargo). Most of the concentrations of the detected pesticides were far below their respective maximum contaminant level or health advisory level. The highest concentration of a detected pesticide, with respect to a health-based standard, was of bentazon at 70 percent of its health advisory level. The wells with pesticide detections were located in the Elk Valley, Fordville, Karlsruhe, Lake Souris, New Rockford and Strawberry Lake aquifers. Overall, pesticide contamination in these aquifers is limited in extent.

Nitrate plus nitrite as nitrogen (N) was detected above 0.05 milligrams per liter in 51 wells, or 24 percent of the wells sampled. Concentrations in 15 wells, 7 percent, exceeded the maximum contaminant level of 10 milligrams per liter (N). Based upon sampling site inventories, many of the nitrate detections were associated with shallow well depth, shorter distance from the top of the well to the top of the screened interval, and shorter distance from the water table to the top of the screen. A majority of the pesticide and nitrate detections are believed to be associated with point sources of contamination.

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INTRODUCTION AND PURPOSE

The maintenance of a baseline description of groundwater quality is an essential element of a statewide comprehensive groundwater protection program. In recent years, concern for the quality of our environment and drinking water has increased as we learn that many states in the country have experienced groundwater contamination from a variety of point and nonpoint sources of pollution. Typically in North Dakota, available groundwater resources underlie agricultural areas; however, limited data exists to evaluate whether agricultural chemicals have impacted groundwater quality of the state on a broad scale. The goal of this project is to provide data relating to the overall quality of North Dakota's groundwater resources, with an emphasis on agricultural chemicals. Since 1992, several aquifers have been monitored each year of the project. Aquifers are resampled every five years in an effort to determine groundwater quality trends. Monitoring is conducted through the use of existing domestic wells, monitoring wells, livestock wells, public supply wells and irrigation wells that meet construction standards and sampling requirements described later in this report.

Monitoring conducted in 1996 marked the completion of the first-round monitoring for 45 of the highest priority glacial drift aquifers in North Dakota. In 1998, the Denbigh, Elk Valley, Fordville, Inkster, Lake Souris and Shell Valley aquifers were sampled for the second time since the 1992 initiation of the monitoring program. The Karlsruhe, McVille, New Rockford, Strawberry Lake and Turtle Lake aquifers also were added to the sampling schedule in 1998 (Figure 1). These 11 aquifers are composed primarily of sand and/or gravel and have shallow water tables ranging from just below the ground surface to approximately 50 feet below grade. Several increasingly are being used for irrigation. Wells included in the study were sampled primarily during May through October 1998. The NDDoH, Division of Water Quality, also installed monitoring wells in several of the aforementioned aquifers. Because they were installed so late in the year -- from late October to mid-December – several of these wells were not sampled until after the regular sampling season in 1999, at which time resampling of the wells with pesticide detections in 1998 was also carried out. Results from the monitoring will provide useful information about the overall quality of groundwater in the state.

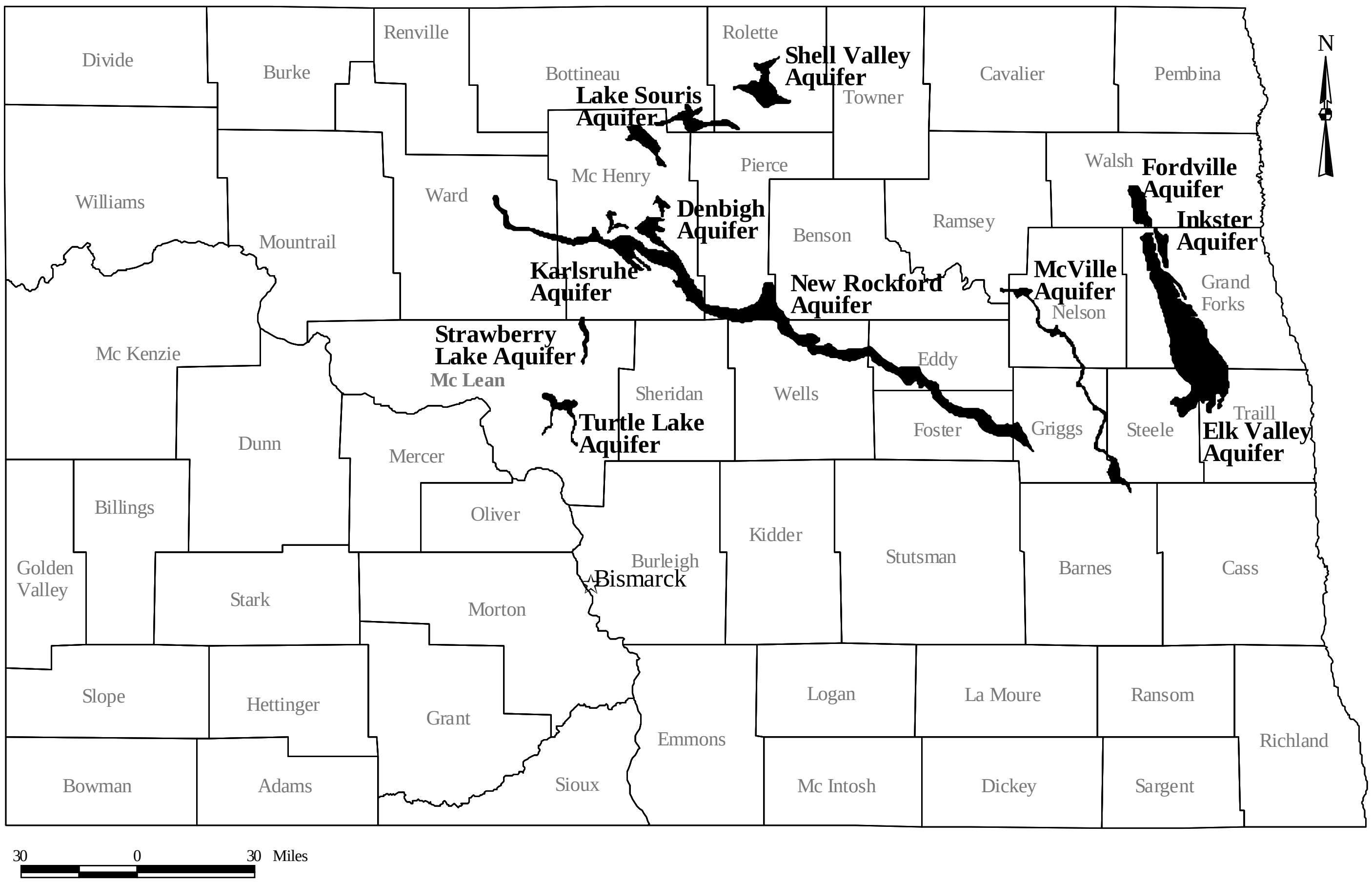

FIGURE 1. Locations of aquifers sampled in 1998 for the North Dakota Groundwater Monitoring Program

SUMMARY OF PREVIOUS INVESTIGATIONS

In recent years, several studies have been initiated to determine the presence and extent of pesticides in groundwater. The United States Environmental Protection Agency (EPA) (1990; 1992) conducted the National Pesticide Survey between 1988 and 1990 to determine the frequency and concentration of pesticides and nitrates in private and public drinking water wells. The survey investigated the association of pesticide detections with various factors such as pesticide use and groundwater vulnerability. For the survey, EPA sampled 566 community water system and 783 rural domestic drinking water wells throughout the nation for the presence of 126 pesticides and degradates, as well as nitrate. Of the analytes, 17 were detected in the survey, with five detected at levels above their respective Maximum Contaminant Level (MCL) or Health Advisory Level (HAL). Based on its findings, EPA estimated that approximately 9,850 (10 percent) community water system and 446,000 (4 percent) rural domestic wells in the United States contained concentrations of at least one pesticide above the minimum reporting level.

Glatt (1985) conducted a study of selected private and public wells to determine the presence of picloram in groundwater in Rolette County, N.D. Of the 126 water samples collected, picloram was found in 11 samples, ranging from less than 0.02 to 0.85 micrograms per liter (μg/l). All positive sites were retested, with picloram concentrations confirmed in four wells, ranging from 0.05 to 3.56μg/l.

In 1986, Glatt sampled 92 municipal drinking water supply systems, with at least one municipal system sampled in 52 of the 53 counties in North Dakota. Water samples were analyzed for one or more of the following agricultural pesticides: aldicarb, fenvalerate, picloram, methyl parathion and 2,4-D. At least one of the five agricultural chemicals was detected in 10 of the water systems. Picloram, with concentrations ranging from 0.08 to 1.46 μg/l, was the pesticide detected in seven of the 10 positive sample locations. Three separate municipal drinking water systems had possible detections of ethyl parathion (less than 0.02 μg/l), methyl parathion (less than 0.04 μg/l), and trifluralin (less than 0.03 μg/l), respectively.

Murphy and Greene (1992) investigated the presence of picloram and 2,4-D on four tracts of land owned by the United States Bureau of Land Management in the Denbigh Sand Hills of McHenry County, N.D. A total of 68 groundwater samples and 33 sediment samples were collected. The concentrations of picloram detected in groundwater ranged from 0.07 to 107 μg/l, and from 10 to 160 μg/l in the sediment. Concentrations of 2,4-D in groundwater ranged from 0.09 to 2.19 μg/l, and up to 20 μg/l in sediment samples.

Montgomery et al. (1988) collected baseline information from the Oakes aquifer for the purpose of assessing the environmental impact involving the Garrison Diversion Irrigation Project transfer of Missouri River water to the James River. A 31-square-kilometer test site was developed by the United States Bureau of Reclamation, with the installation of 98 observation wells on a 0.8-kilometer grid, four large drainage lysimeters, and 70 kilometers of slotted, plastic drain pipe. A total of 229 water samples were collected from the observation wells, lysimeters and manholes constructed in the drains for the period 1985 through 1987. Samples were analyzed for the presence of four commonly used herbicides: alachlor, metolachlor, simazine and atrazine. Concentrations of alachlor were detected in six of the 229 samples, ranging from a trace (0.2 μg/l) to 1.2 μg/l. Three of the detections were from samples of the same well collected during three different sampling episodes. The other three detections were from two lysimeters and a drain manhole. No detections of the other three herbicides were confirmed in any of the samples.

In a statewide study of 346 community and non-transient, non-community public water systems, Abel (1992) surveyed for the presence of certain regulated and non-regulated Volatile Organic Compounds (VOCs). In addition, those systems deriving their water supply from groundwater were tested for 14 herbicides and six insecticides, selected on the basis of their use in North Dakota and their mobility and persistence in soil. Two pesticides, alachlor (0.55 μg/l) and picloram (1.99 μg/l), were detected, representing less than 1 percent of the systems in the study.

During the first four years of the Ambient Groundwater Monitoring Program, Radig and Bartelson (1992, 1993, 1994 and 1995) completed monitoring of 30 glacial drift aquifers.

During the 1992 sampling season, Radig and Bartelson (1992) sampled 137 wells in the Oakes, Warwick and Icelandic aquifers for general inorganic chemistry, nitrate plus nitrite and 44 selected pesticides. The established protocol for the study has been followed in succeeding years of the North Dakota Groundwater Monitoring Program. Only three of the 137 wells contained detectable pesticide concentrations, all of which were considerably below their respective MCL or HAL. Nitrate plus nitrite was detected in 37 wells and was above the 10 milligrams per liter (mg/l) as nitrogen (N) MCL in eight wells. Site surveys indicated that all of the pesticide detections and most of the nitrate plus nitrite detections were suspected of being associated with a point source of contamination.

During the 1993 sampling season, Radig and Bartelson (1993) sampled 117 wells in the Denbigh, Elk Valley, Fordville, Inkster, Lake Souris and Shell Valley aquifers. Twenty-one of the 117 wells contained detectable pesticide concentrations, all of which were considerably below their respective MCL or HAL. Seven of the wells had confirmed detections of the same pesticide in follow-up sampling events. Nitrate plus nitrite was detected in 37 wells, but was above the 10 mg/l (N) MCL in only three wells. Site surveys indicated that many of the pesticide detections and most of the nitrate plus nitrite detections were suspected of being associated with a point source of contamination.

During the 1994 sampling season, Radig and Bartelson (1994) sampled 149 wells in the Galesburg/Page, Hankinson, Marstonmoor Plain, Milnor Channel, Sand Prairie and Sheyenne Delta aquifers. Twenty-six of the 149 wells contained detectable pesticide concentrations, all below their respective MCL or HAL. Nitrate plus nitrite was detected in 84 wells, with only four samples above the 10 mg/l (N) MCL. Site surveys indicated that many of the pesticide detections and more than one-half of the nitrate plus nitrite detections were suspected of being associated with a point source of contamination.

During the 1995 sampling season, Radig and Bartelson (1995) sampled 186 wells in 15 aquifers, including the Bismarck, Burnt Creek, Glenview, Wagonsport, Painted Woods Lake, Missouri River, Lake Nettie, Manfred, Carrington, Juanita Lake, Edgeley, LaMoure, Englevale, Guelph and Strasburg aquifers. Pesticides were detected in five wells, all at concentrations less than 5 percent of any health-based standards. Three of the five wells had confirmed detections of the same pesticide in follow-up sampling events. Nitrate plus nitrite was detected in 81 wells, with concentrations in 10 of the wells greater than the MCL. As in previous investigations, most detections are suspected of being associated with a point source.

Bartelson and Gunnerson (1996), continuing the North Dakota Groundwater Monitoring Program, reported finding eight wells with detectable concentrations of at least one pesticide, out of a total of 163 wells sampled in 15 aquifers. Seven pesticide compounds were identified in the initial samples collected; two pesticides were confirmed in follow-up samples. Most detected concentrations were well below any health-based standards; however, one pesticide, dinoseb, was detected at a concentration greater than two and one-half times the MCL. This detection was determined to be the result of back-siphoning while filling a sprayer. Dinoseb was not detected in a follow-up sample collected from the well. Nitrate plus nitrite was detected in 93 wells; nitrate concentrations in 12 wells were greater than the MCL.

Schuh et al. (1995) investigated the relationship between groundwater recharge and agricultural chemical movement. The investigation was conducted in a crop production plot at the Carrington Research Extension Center in Foster County, N.D., to assess the impact of pesticides on the Carrington aquifer, a buried sand and gravel deposit existing primarily under confined conditions. Monitoring wells were installed around the plot and nested at three depths: in the vadose zone, in the saturated overlying till and at the top of the aquifer. Low concentrations of pesticides were detected at all sampling depths; however, detections were generally sporadic and spatially and temporally discontinuous. Most pesticide detections were below levels of toxicological concern, and there was no evidence of pesticide accumulation in the saturated till or the Carrington aquifer. In general, the investigators concluded that pesticide detections corresponded to periods of recharge and were depression-focused.

STUDY DESIGN

The North Dakota Groundwater Monitoring Program is designed to provide a consistent approach to water quality determinations by defining target populations and criteria for sample site selection.

Target Population

The target population, or set of environmental units, that this study addresses includes all groundwater wells capable of producing significant amounts of water. Statistically, it is impossible to use a whole aquifer as the target population for a monitoring study because it is impossible to take an "overall" sample of an aquifer. Groundwater samples must be collected from wells or springs; therefore, the population that most closely correlates to the overall quality of an aquifer is the set of all wells completed in an aquifer.

Criteria for Acceptable Sampling Points

Because of the necessity to produce reliable and representative data, some limitations were put on the target population. A number of criteria were used to determine whether a well was acceptable for use as a sampling point. These criteria were used to ensure that the sample would be representative of groundwater in that area and that there was data available to determine relationships between well and/or site characteristics and groundwater quality. The criteria used include:

- Wells capable of being pumped dry by small capacity pumps (one to two gallons per minute), or that can be bailed dry were not included in the target population;

- The well must have a drilling and well completion log available to document the construction of the well and the geology of the aquifer material at the site;

- The well must be accessible and open for bailing or have an operable pump installed;

- The well must be capable of being sampled before any treatment of the water occurs; and,

- Permission of the owner or other responsible person must be received before the well may be sampled.

Sampling Grid

In an ideal monitoring program, every population unit in the target population would be sampled. However, due to the practical constraints of time, budget and personnel, not all wells could be sampled. A sampling grid based on township, range and section boundaries was used. The size of a grid unit was one section, normally one square mile. Sections that only partially overlie an aquifer were included with that aquifer if they contained acceptable sampling points.

Using Gilbert's (1987) method of determining "hot spots," a circular area of non-point source contamination with a radius of 0.56 miles has a 90 percent chance of being detected by a one-mile-square uniform sampling grid. Because the sampling grid was not precisely uniform (the sample point could be anywhere within the grid block), the size of this 90-percent-confidence detection circle would be slightly more or less than 0.56 miles.

Selection of Sampling Points

A maximum of one well from each section was sampled for this survey. The shallowest well that met the sampling criteria and was nearest the center of the section was selected for sampling. Based upon previous sampling results (only one questionable pesticide detection), wells with a depth greater than 100 feet generally were not sampled. Whenever possible, an alternative well was chosen for sampling in case the first selection was not capable of being sampled.

The only bias built into the monitoring program was toward shallower wells rather than deeper wells and toward newer wells rather than older wells, because drilling logs were not required prior to enactment of the North Dakota Water Well Construction Code in 1971. The other characteristics of the sample site, such as water use and nearby land use, were strictly random.

Criteria for Selecting Aquifers

Radig (1997) developed a system of prioritizing aquifers that may have the highest potential for groundwater pollution. The Geographic Targeting System for identifying those aquifers is based on the DRASTIC groundwater vulnerability assessment model (Aller et al., 1987), as well as components for agricultural chemical usage and risk. The acronym DRASTIC stands for **d**epth to groundwater, **r**echarge, **a**quifer media, **s**oil media, **t**opography, **i**mpact of the vadose zone and hydraulic **c**onductivity. These parameters are considered important in the transport of contaminants to groundwater. The Geographic Targeting System does not evaluate small areas within aquifers to determine recharge zones or critical areas, but rather evaluates aquifers as whole units to determine their relative average pollution potential. In some cases, large aquifers were subdivided into hydrogeologic settings with similar characteristics to aid in the evaluation process. Aquifers are chosen for groundwater monitoring based on a combination of their pollution potential and the volume of groundwater withdrawn from the aquifer for beneficial uses, such as drinking water supplies or irrigation. Aquifers are periodically re-evaluated for factors such as permitted water usage; therefore, an aquifer's ranking in the targeting system may move up or down accordingly.

Temporal Variability

All wells from which there was a pesticide detection in the initial sample are normally resampled at least once for confirmation purposes. Wells with sample analyses that exhibit a laboratory chromatographic peak below minimum detection limits, but that resembles a peak caused by pesticides, also will be resampled.

LOCATION NUMBERING SYSTEM

The wells and other data collection points mentioned in this report are numbered according to a system based upon the location in the public land classification of the U.S. Bureau of Land Management. The system is illustrated in Figure 2. The first numeral in the illustration denotes the township north of a base line, the second numeral denotes the range west of the fifth principal meridian, and the third numeral denotes the section in which the well is located. The letters A, B, C and D designate the northeast, northwest, southwest and southeast quarter section, quarter-quarter section and quarter-quarter-quarter section (10-acre tract), respectively. For example, well 161-55-15DAB is in the NW$^1/_4$NE$^1/_4$SE$^1/_4$ of section 15, T. 161 N., R. 55 W. Consecutive end digits are added if more than one well or data collection point is within a given tract. Site identification numbers used for this study are the township, range, section and quarter digits combined without any dashes.

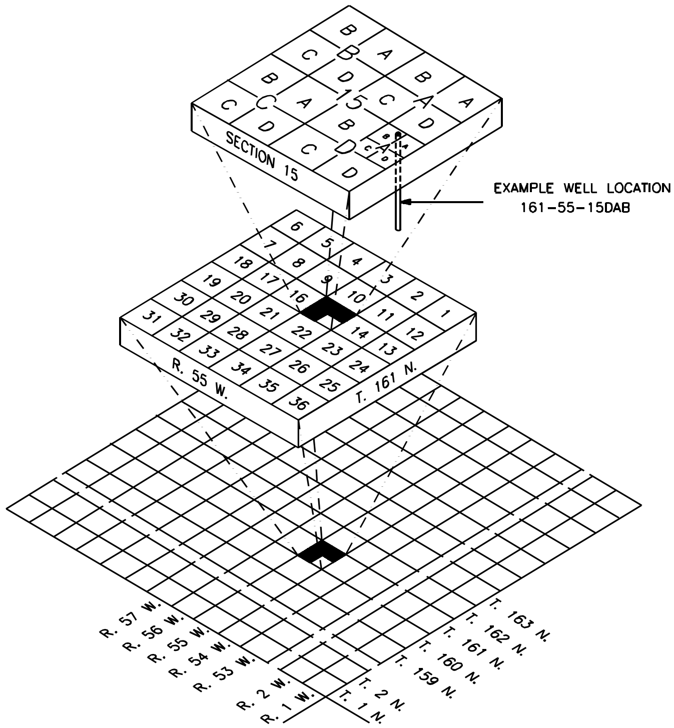

FIGURE 2. System of numbering wells, test holes, and springs

QUALITY ASSURANCE / QUALITY CONTROL METHODS

The objective of a groundwater monitoring program is to produce data that is valid, accurate, complete, representative of the medium being sampled and comparable with other data. In view of this objective, a set of Standard Operating Procedures was developed and followed to encompass every aspect of groundwater monitoring, including sample collection, handling, preservation, field monitoring and uniform standards for the analysis and reporting of chemical data. Included in these procedures are certain methods for providing Quality Assurance/Quality Control (QA/QC). The Standard Operating Procedures used for this project include

- Locating the well site and collecting latitude/longitude data;
- Surveying well owners and filling out the field inventory form;
- Measuring water levels;
- Measuring temperature, pH and electrical conductivity;

- Well purging;
- The use and maintenance of sampling mechanisms; and
- Collecting and preserving groundwater samples.

Field sampling personnel were required to be familiar with these procedures and to have appropriate instruction manuals available for reference in the field. The project leader also served as the quality assurance representative, providing quality assurance oversight for the project.

A number of quality control checks were used in the field, including equipment calibration; collecting field duplicate samples to establish sampling and laboratory precision; collecting blank samples to assure noninterference with preservatives, sampling equipment or sample containers; and the use of standard solutions, reagents and lab-packaged vials of preservatives. A field duplicate sample and a field blank sample were collected with approximately one out of every 10 water chemistry samples collected. A notation was made in the site inventory form that the sample was a duplicate or a blank. The laboratory was not informed which samples were duplicates or blanks.

All equipment was inspected prior to departure for the field. Conductivity and pH meters were calibrated according to the manufacturer's specifications using standard solutions. Meters were calibrated daily and during sampling activities when necessary. Teflon® bailers and peristaltic pump tubing were used to prevent adsorption of pesticides on the sampler material and to facilitate effective cleanup.

All wells were purged prior to sampling to ensure that groundwater samples were representative of the aquifer. Purging the well removes stagnant groundwater in the well casing that may possess chemical and physical characteristics which are not representative of the aquifer water quality. Monitoring wells were purged by removing a minimum of three well volumes of water, and until stabilized readings of electrical conductivity, pH and temperature were obtained. Water pumps in wells for domestic, livestock and irrigation uses were allowed to run a minimum of five minutes prior to sample collection to increase the likelihood of collecting a representative sample.

To minimize cross-contamination of samples, the bailers and other equipment were decontaminated after sampling each well. Because the focus of this study was on pesticides (organics), decontamination procedures were followed that were appropriate for these parameters. The equipment was first washed with alconox, a non-phosphate detergent, then rinsed with deionized water. This was followed by an acetone rinse and then a hexane rinse. Disposable latex lab gloves were worn throughout sampling and decontamination processes to prevent contaminants from the skin from coming into contact with the sample and to protect the skin from the acetone and hexane rinses. Water level measurement tapes were rinsed with deionized water between measuring events. The gloves and the nylon cord used on the bailers were discarded and replaced after each well was sampled. Sample bottles were double-rinsed with sample medium, or, for blank samples, with deionized water. All samples were appropriately preserved, packed in ice and transported to the laboratory as necessary to comply with appropriate analytical holding times.

Prescribed field procedures, site inventory forms (Appendix A) and labels were used to ensure the orderly and consistent handling of all data collected. At the time of sample collection, field data and associated descriptive information were recorded on the site inventory form. This form includes information about the site location, well or location ID number, sampler(s), date and time of sample collection, method of sample collection, sampling equipment used and well-purging data. Immediately prior to collecting the sample, the sample container was labeled with the well or location ID number, date, time and name or initials of sampler(s). Field data recorded in the laboratory report was checked against site inventory forms for accuracy.

All samples were analyzed by the North Dakota Department of Health, Division of Chemistry (NDDoH, DC), utilizing EPA-approved analytical methods. Sample custody procedures, analytical methods used in the analysis of samples, and calibration procedures for the NDDoH-DC laboratory are included in the NDDoH, DC Quality Assurance Program Plan (1997).

HYDROGEOLOGIC DESCRIPTIONS OF THE AQUIFERS

Denbigh and Lake Souris Aquifers

The Denbigh and Lake Souris aquifers are located in Bottineau, Rolette and McHenry counties of north-central North Dakota, in an area referred to as the glacial Lake Souris plain (Bluemle, 1982). (Refer to Figure 1, Figure C-1 and Figure C-2 for plan views of the aquifers' locations and areal extent.) The entire area was glaciated, with surficial Pleistocene and Holocene deposits overlying the Cretaceous Fox Hills Formation or, in a few isolated locations, the Pierre Shale. Bluemle (1979) collectively refers to all sediment relating to glacial deposition (deposited directly by the ice, or by flowing and ponded water associated with the ice) as the Coleharbor Group; he designates the Holocene deposits of primarily river, pond, mass movement and eolian sediments as the Oahe Formation.

The present-day topography of Bottineau, McHenry and Rolette counties was formed by glacial ice and by glacial Lake Souris, which covered much of the area when the glacier melted. Glacial Lake Souris apparently existed at two elevations in the counties. The more restricted, upper, older level probably indicates the existence of numerous ice-walled or supraglacial lakes when a large portion of the lake basin was still filled with ice. As the ice melted, streams enlarged the lake and delivered a large amount of material -- in many places depositing more than 50 feet and in some places up to 125 feet – of lake sediment in this lower, more extensive lake. The deposits are primarily silts and flat-bedded, well-sorted, very fine to medium sands, most likely turbidity-current deposits. Modification of much of the lake plain surface has resulted from wind action on the sandy silt, and large, extensive dune deposits are found on top of the lake deposits in places. In areas where dunes did not develop, a fairly continuous layer of eolian sediment mantles the surface (Bluemle, 1982). The Lake Souris aquifers are comprised of shoreline deposits left mainly along the Souris River as glacial Lake Souris retreated northward (Wanek, 2000).

The Denbigh aquifer extends from northwest of the town for which it is named south-southeast to the Souris River valley. The aquifer, comprised of a surficial aquifer and, in part, a buried valley aquifer, has an areal extent of approximately 25 square miles. The thickness of the aquifer ranges from about 15 to 80 feet, with an average thickness of 40 feet. Water levels range from approximately 3 to 17 feet below ground surface. The general direction of groundwater flow within the aquifer is to the south and southeast toward the Souris River valley (Randich, 1981).

The Lake Souris aquifers are named for glacial Lake Souris and occur as isolated areas of surficial sand of glacioaqueous or eolian origin (Randich, 1981). Wanek (2000) states that the aquifers are comprised of shoreline deposits left mainly along the Souris River as glacial Lake Souris retreated northward. In McHenry County, the aquifers occupy an area of approximately 45 square miles (Randich, 1981). The aquifers are not well defined in Bottineau County; however, the most extensive of these, having an areal extent of about 25 square miles, is located in the southeastern part of the county near Willow City (Randich and Kuzniar, 1984). The thickness of the aquifer ranges from approximately 5 to 55 feet, with an average thickness of about 20 to 25 feet; water levels range from less than a foot to about 15 feet below ground surface (Randich, 1981).

Recharge to the Denbigh and Lake Souris aquifers is primarily by direct infiltration of precipitation and snowmelt. It is estimated that approximately 96,000 acre-feet of water is available from the Denbigh aquifer and 76,000 acre-feet from the Lake Souris aquifers (Randich, 1981).

Elk Valley and Fordville Aquifers

The Elk Valley and Fordville aquifers are located in the Lake Agassiz Plain, a large flat area of eastern North Dakota and northwestern Minnesota more commonly known as the Red River Valley (Jensen and Klausing, 1971). The Agassiz Lake Plain formerly was occupied by Lake Agassiz, a large proglacial lake which formed to the south of the receding late Wisconsinian glacier (Bluemle, 1967). (Refer to Figure 1, Figure C-3 and Figure C-4 for plan views of the locations and areal extent of the aquifers.)

Geologically, the Elk Valley and Fordville aquifers are part of the Elk Valley delta and share a common origin, as does the Medford aquifer, located between the Elk Valley and Fordville aquifers. However, they are not hydraulically connected and are, therefore, considered separate aquifers. The Forest River has cut channels through the Elk Valley delta deposits into the underlying glacial till, separating the Medford aquifer from the Fordville aquifer to the north and from the Elk Valley aquifer to the south. Based upon the origin and deposition of the aquifer material, the water chemistry and hydraulic characteristics of the Medford aquifer are probably very similar to those of the Elk Valley and Fordville aquifers. In addition, its location would indicate similar agricultural practices regarding pesticide and fertilizer usage. However, because of the absence of observation wells and of private wells with available well logs, no samples were collected from the Medford aquifer.

One of the more important water sources in eastern North Dakota, the Elk Valley aquifer is comprised primarily of delta-outwash plain deposits (Kelly and Paulson, 1970). Prior to, or in the early stage of, the formation of Lake Agassiz, a small proglacial lake was formed between the ice front and the Pembina escarpment by the ponding of meltwater and runoff during a stillstand of the ice. Initially, silt and clay sediments were deposited in the proglacial lake; during the same time period, the Edinburg end moraine, which forms the eastern boundary of the aquifers in Walsh and Grand Forks counties, was being deposited along the ice margin. Increased runoff and meltwater resulted in the deposition of coarser-grained material on top of the silts and clays. Large, valley-train sand and gravel deposits in the northern part of Grand Forks County grade into the fine-grained sands, silts and clays which comprise the Elk Valley Delta in the south-central portion of the county (Hansen and Kume, 1970).

Although there is local variation of the aquifer deposits, the texture of the aquifer materials generally grades from coarser to finer north to south affecting the permeability and productivity of the aquifer, the potential yields becoming progressively smaller toward the south. According to Jensen and Klausing (1971), the Elk Valley deposits in Traill County consist predominantly of silt and clay, interbedded in places with very fine to fine sand as much as 65 feet thick. Only about one-fourth of the aquifer deposits in Traill County are permeable enough to yield at least 10 gallons per minute. According to Downey and Armstrong (1977), the Steele County portion of the Elk Valley aquifer consists of sand and gravel interbedded with silt and clay ranging from a few feet to approximately 100 feet thick. They estimate an average thickness of approximately 23 feet for the sand and gravel units, which are generally found at less than 100 feet below the land surface. Because of the sandy, permeable soils that characterize the Elk Valley deposits, rainfall and snowmelt are readily absorbed and there is little surface runoff, leaving large areas undissected by streams (Kelly and Paulson, 1970.

The Elk Valley aquifer underlies about 200 square miles in western Grand Forks County (Kelly and Paulson, 1970), 60 square miles in northwestern Traill County (Jensen and Klausing, 1971), and 48 square miles in northeastern Steele County (Downey and Armstrong, 1977).

The Elk Valley aquifer is generally unconfined, and the water table is approximately 10 feet below the land surface. Kelly and Paulson (1970) place the maximum known thickness of the aquifer in Grand Forks County at 61 feet, with an average thickness of 34 feet. From this, they estimate approximately one million acre-feet of water are available from storage in the Grand Forks portion of the aquifer. For that portion of the aquifer in Steele County, Downey and Armstrong (1977) estimate 110,000 acre-feet of water may be available from the sand and gravel units. No estimates were found for the Traill County portion of the aquifer.

According to Jensen and Klausing (1971), recharge to the Elk Valley aquifer is derived by direct infiltration of rainfall and snowmelt; water is discharged by pumping, evapotranspiration and lateral movement into adjacent deposits. Kelly and Paulson (1970) state that large quantities of groundwater from the Elk Valley aquifer are discharged through springs in the stream valleys of the Forest and Turtle rivers, which transect the aquifer.

The Forest River has cut a channel through the Elk Valley delta deposits, into the underlying glacial till. This separates the Fordville aquifer from the Medford and Elk Valley aquifers. The Fordville aquifer extends from approximately nine miles north to one mile south of the community of Fordville, from which its name is derived, occupying an area of about 33 square miles. Consisting primarily of gravel with interbedded silt and sand, the average thickness of the aquifer is estimated to be approximately 20 feet. Information obtained from test holes indicate that the Fordville aquifer consists of two units. The lower unit is composed of silty sand and is thickest in the northeastern portion of the aquifer, thinning to the south and west. Information obtained from test holes indicates that the lower unit extends underneath and predates the Edinburg moraine to the east. The upper unit of the aquifer consists of sandy gravel and was probably deposited in shallow water. The Edinburg moraine forms the eastern boundary of the upper unit (Downey, 1973).

The Fordville aquifer is unconfined, and the highly permeable deposits allow rapid absorption of rainfall and snowmelt, the primary sources of recharge to the aquifer. Another source of recharge is by infiltration from the North Branch Forest River during periods of high flow. The aquifer discharges to pumping wells, evapotranspiration and to the Forest River. An estimated 63,000 acre-feet of water are available from storage in the aquifer (Downey, 1973).

Inkster Aquifer

The Inkster aquifer underlies approximately 11 square miles in northwestern Grand Forks County and is located just west of the community of Inkster, from which the aquifer derives its name. (Refer to Figure 1 and Figure C-3 for plan views of the aquifer's location and areal extent.)

The Edinburg moraine to the west separates the Inkster aquifer from the Elk Valley aquifer, the South Branch Forest River forms the northern boundary and it is bounded on the east by Campbell Beach and Tintah scarp of Lake Agassiz (Kelly and Paulson, 1970).

Following deposition of the Edinburg end moraine, marking the last stillstand of the ice in Grand Forks County, the development of Lake Agassiz and its associated landforms occurred. Sand and gravel were deposited for a short distance east of the Edinburg moraine when the glacial ice began to recede (Hansen and Kume, 1970). This outwash delta deposit comprises the Inkster aquifer.

Because of similar depositional environments, the lithologies and hydrologic characteristics of the Inkster and Elk Valley aquifers are also similar (Kelly and Paulson, 1970). The aquifer is composed primarily of well-sorted, fine- to coarse-grained sand, with local inclusions of fine gravel. The aquifer materials include very little silt and clay. Data obtained from test holes indicate that the maximum thickness of the aquifer is approximately 50 feet, with an average thickness of about 30 feet. The aquifer thins toward the south and is not capable of yielding large quantities of water. Kelly and Paulson (1970) estimate that approximately 60,000 acre-feet of water are available from storage in the Inkster aquifer.

The Inkster aquifer is an unconfined aquifer and the water table is generally 5 to 10 feet below the land surface. Recharge is primarily by direct infiltration of precipitation, and discharge is from pumping wells, evapotranspiration and from numerous springs along the South Branch Forest River. According to Kelly and Paulson (1970), one of the larger springs, known locally as the Inkster Spring, discharges from 200 to 700 gallons per minute (gpm).

Karlsruhe Aquifer

The Karlsruhe aquifer underlies the city of Karlsruhe and has an areal extent of about 20 square miles in south-central McHenry County. (Refer to Figure 1 and Figure C-2 for plan views of the aquifer's location and areal extent.) Wanek (2000) describes the aquifer as a surficial sand and gravel deposit of glacial outwash and delta/lake shoreline origin. These deposits range in thickness from 5 to 40 feet, with an average thickness of about 25 feet (Randich, 1981).

The New Rockford aquifer underlies and borders the north side of the Karlsruhe aquifer. The gradient of the Karlsruhe aquifer is from higher land southwest of Karlsruhe, northeast to the New Rockford aquifer. Wanek (2000) states that northeast of Karlsruhe water moves from the Karlsruhe aquifer to deeper sand and gravel south of a lateral barrier which separates the secondary diversion channel from the primary glaciomarginal channel in which the New Rockford aquifer is located.

Recharge to the Karlsruhe aquifer occurs from infiltration of precipitation. Discharge from the aquifer is to nearby potholes and through wells screened in the aquifer. Randich (1981) estimated about 48,000 acre-feet of groundwater were available from storage in the Karlsruhe aquifer.

McVille Aquifer

The McVille aquifer is a buried channel aquifer extending south-southeastward from Stump Lake in west-central Nelson County, through eastern Griggs County, and into northeastern Barnes County. (Refer to Figure 1 and Figure C-5 for plan views of the aquifer's location and areal extent.) The aquifer ranges in width from a quarter of a mile to about half a mile, with an average width of about three-eighths of a mile (Downey, 1973). The aquifer ranges in thickness from a foot to as much as 300 feet in the central part, with an average thickness of 80 feet.

Recharge to the aquifer is from direct precipitation, snowmelt and inflow from the Sheyenne River (Downey and Armstrong, 1977). Discharge occurs primarily along the Sheyenne River, with a small quantity discharging to Stump Lake. Based on an areal extent of about 12 square miles, an average saturated thickness of 80 feet, and a storage coefficient of 0.15, Downey (1973) estimates that 200,000 acre-feet of water is available from storage in the McVille aquifer.

New Rockford Aquifer

The New Rockford aquifer is a buried valley aquifer that underlies approximately 152 square miles in parts of Wells, Eddy, Foster and possibly Griggs counties (Buturla, 1970). In the Karlsruhe area, the New Rockford aquifer extends along and underlies the north side of the Karlsruhe aquifer (Wanek, 2000). (Refer to Figure 1 and Figure C-2 for plan views of the aquifer's location and areal extent.)

The New Rockford aquifer channel deposits developed sometime before the Late Wisconsin glaciers occupied this part of North Dakota. According to Patch and Knell (1988), the aquifer generally consists of sand and gravel with interbedded shale and silt lenses. The sand and gravel is composed of predominantly rounded to angular igneous and metamorphic rock fragments, quartz, carbonates, shale and lignite. The estimated average thickness of these deposits is about 125 feet. They are overlain by more than 100 feet of fine-grained glacial drift and underlain by the Pierre Formation (Buturla, 1970).

Recharge to the aquifer occurs as underflow from the Manfred and Heimdal aquifers, downward infiltration of precipitation through the overlying drift, and overflow from the adjacent bedrock deposits (Buturla, 1970). Discharge from the aquifer is predominantly from pumping wells and to the Sheyenne River valley. Buturla (1970), estimates that 3,500,000 acre-feet of groundwater is stored in the aquifer, only part of which would be available through wells.

Shell Valley Aquifer

The Shell Valley aquifer system underlies about 56 square miles in south-central Rolette County (Randich and Kuzniar, 1984). The Turtle Mountains form the northern boundary of the aquifer. (Refer to Figure 1 and Figure C-6 for plan views of the aquifer's location and areal extent.)

The Shell Valley aquifer system is comprised of an unconfined, surficial-outwash aquifer and a narrow, confined, melt-water channel aquifer (Randich and Kuzniar, 1984). According to Deal (1971) and Randich and Kuzniar (1984), the aquifer system is composed of sand and gravel interbedded with silt, clay and till lenses. These sediments are predominantly of stream origin, outwash or melt-water, deposited during the last glaciation (Deal, 1971). Based upon test holes and wells, the thickness of the deposits has been estimated to range from approximately 6 to 117 feet, with an average saturated thickness of 35 feet. These outwash deposits generally overlie glacial till or the Cretaceous Fox Hills Formation (Randich and Kuzniar, 1984).

Recharge to the aquifer is mainly through surface infiltration of precipitation and through stream recharge during high flows. Discharge from the aquifer is predominantly from pumping wells, seeps and springs along river and creek beds, and evapotranspiration. In some of the stream valleys that cut across the surface of the aquifer, water levels in observation wells may be less than one foot below the land surface. In the buried valley, water levels are about 35 feet below the land surface. It has been estimated that approximately 190,000 acre-feet of water are available from storage in the Shell Valley aquifer system. Groundwater flow in the aquifer is generally to the southwest (Randich and Kuzniar, 1984).

Strawberry Lake Aquifer

The Strawberry Lake aquifer occupies a buried bedrock valley that extends from its junction with the Lake Nettie aquifer into McHenry County, having an areal extent of 18 square miles (Klausing, 1974). (Refer to Figure 1 and Figure C-7 for plan views of the aquifer's location and areal extent.) The aquifer deposits consist of several sand and gravel beds; deposit thicknesses range from 23 to 164 feet and average about 65 feet (Klausing, 1974).

Locally, recharge to the Strawberry Lake aquifer is from leakage from the Horseshoe Valley aquifer and possibly from Strawberry and Camp lakes (Klausing, 1974). Groundwater flow in the Strawberry Lake aquifer is southward along the axis of the buried valley toward the Lake Nettie aquifer. Swanson (1996) describes a hydraulic continuity between the two aquifers, with groundwater flow discharging from the Strawberry Lake aquifer into the Lake Nettie aquifer. The base of Strawberry Lake aquifer is about 150 to 200 feet higher in elevation than the base of the larger buried valley occupied by the Lower Lake Nettie aquifer. According to Klausing

(1974), approximately 110,000 acre-feet of water should be available from storage within the Strawberry Lake aquifer.

Turtle Lake Aquifer

The Turtle Lake aquifer has an areal extent of 26 square miles and underlies an area extending southward from the southeast arm of Lake Audubon to just west of the city of Turtle Lake. (Refer to Figure 1 and Figure C-8 for plan views of the aquifer's location and areal extent.) The aquifer lies within an eastward-trending, buried bedrock valley several miles south of the larger valley occupied by the Lake Nettie aquifer (Swanson, 1996).

The top of the aquifer ranges from ground surface to 84 feet below ground surface. The aggregate thickness ranges from 12 to 127 feet and averages about 42 feet. Lithology of the aquifer consists primarily of very fine to very coarse sand intermixed with fine to coarse gravel. Recharge to the aquifer occurs primarily from infiltrating precipitation. Klausing (1974) estimates that about 100,000 acre-feet of water should be available from storage in the aquifer.

DESCRIPTION OF SITE CHARACTERISTICS

Site Inventory

A site inventory form was developed to collect data that would assist in the interpretation of the analytical results. The form was intended to record conditions around the well that may have an influence on the quality of the groundwater in the area. The form contains sections on well characteristics, activities performed and conditions around the well, as well as the parameters measured during the well-purging process. A copy of the form is included as Appendix A.

The site inventory form was completed by the field personnel who collected the sample(s) at each site. If the collection point was a private domestic, stock or irrigation well or a public water supply well, an interview was conducted with the owner or other responsible person to obtain as much site-specific information as was available. If the collection point was a government agency monitoring well, the collector completed as much of the inventory form as possible from field observation. When possible, drilling log information, such as well depth and diameter, was measured and verified. Water level measurements recorded were those measured at the time of sampling, or those currently reported by the owner in the case of private wells. Water levels from the drilling logs were not entered on the site inventory form unless more current information was unavailable. Site characteristics recorded were those within approximately one-eighth mile or less of the well.

Information from the site inventory forms was entered into a database that was used to relate the field information with the analytical results of the water sampling. The maps on the forms were not entered graphically in the database; however, distance information to potential contaminant sources was included. The field sheets are retained by the Division of Water Quality.

Well Characteristics

More than 90 percent of the wells sampled for this study were monitoring wells, and approximately 7 percent were private domestic wells. Most of these were small-diameter wells (less than 6 inches in diameter) and constructed of PVC casing. Other types of wells sampled include public water supply and livestock wells, constructed of a variety of materials. The wells varied in depth below ground surface and below the water table. The shallowest well sampled had a total depth of 12.5 feet; the deepest well was 186 feet deep. A number of wells were screened across or very near the water table, while the deepest screened interval was approximately 149 feet below the water table. The age of the wells was generally less than 25 years because of the study restriction requiring all wells to have a well-construction log. Table 1 contains a summary of well characteristics for all 11 aquifers included in this report. Tables of well characteristics for each aquifer are located in Appendix D.

TABLE 1
General Well-Construction Statistics
For All Aquifers Sampled 1998

AQUIFER	#	PERCENT
DENBIGH :	6	2.8
ELK VALLEY :	83	38.8
FORDVILLE :	10	4.7
INKSTER :	8	3.7
KARLSRUHE :	19	8.9
LAKE SOURIS :	33	15.4
MCVILLE :	9	4.2
NEW ROCKFORD :	13	6.1
SHELL VALLEY :	19	8.9
STRAWBERRY LAKE :	9	4.2
TURTLE LAKE :	5	2.3
Total :	214	

DEPTH OF WELL	#	PERCENT
< 20 Ft. :	24	11.2 %
20 - 50 Ft. :	132	61.7 %
> 50 Ft. :	56	26.2 %
Unknown :	2	0.9 %

DIAMETER OF WELL	#	PERCENT
< 6 in. :	205	95.8 %
6 - 18 in. :	6	2.8 %
> 18 in. :	1	0.5 %
Unknown :	2	0.9 %

CASING MATERIAL	#	PERCENT
Plastic (PVC or ABS) :	205	95.8 %
Concrete/Brick/Stone :	1	0.5 %
Metallic :	6	2.8 %
Other :	2	0.9 %

DEPTH TO TOP OF SCREENED INTERVAL	#	PERCENT
< 20 Ft. :	45	21.0 %
20 - 50 Ft. :	121	56.5 %
> 50 Ft. :	44	20.6 %
Unknown :	4	1.9 %

DISTANCE FROM WATER TABLE TO TOP OF SCREEN	#	PERCENT
< 10 Ft. :	53	24.8 %
10 - 30 Ft. :	87	40.7 %
> 30 Ft. :	54	25.2 %
Unknown :	20	9.3 %

TYPE OF WELL	#	PERCENT
Monitoring :	194	90.7 %
Private/Domestic :	14	6.5 %
Livestock :	2	0.9 %
Public Supply :	4	1.9 %
Irrigation :	0	0.0 %
Other :	0	0.0

is the number of wells in the category.
% is the percentage of wells in the category.

Site Characteristics

Wells were sampled from a variety of general settings, including fields, pastures, farmyards, Conservation Reserve Program (CRP) acres, roadsides and within town boundaries. Often the sites had characteristics of more than one type of general setting; for example, a well located on the boundary of a farmyard and a pasture, adjacent to a road ditch. In 1995, an additional data field was added to the site inventory form to include a secondary general setting to help account for wells with characteristics of more than one setting. Only wells located near chemical application areas or storage/mixing sites verified by the owner or applicator were recorded as such on the site inventory form and in the database. However, many more wells than verified in the field probably have had chemical application, storage or mixing performed near them. For instance, landowner information about chemical history was rarely available for monitoring wells.

WATER QUALITY ANALYSES

Analytes of Concern

According to a 1992 State Water Commission survey of North Dakota residents, the most important water-related issue is protecting groundwater from contamination. Agricultural chemicals are perceived as a threat to groundwater quality, and wide-spread contamination problems have occurred in other states. The main analytes of concern for this study are agricultural pesticides. The general inorganic chemical nature of each groundwater sample also was determined. Each sample was analyzed for general anions and cations, total nitrate plus nitrite as nitrogen (N), 39 base-neutral pesticides, 13 chlorinated pesticides and eight carbamate pesticides (Table 2). These three pesticide groups are included in the Safe Drinking Water Act, Phase II/V, sampling requirements. By analyzing for the same pesticides as community water systems, results from this study can be correlated more easily with community water system sampling results.

TABLE 2
Summary of Analytical Parameters

Analyte Group	Parameter Analyzed	NDDoH, DC Quantification Limit*	Sample Preservation	Holding Time
Pesticides	Aldrin	0.010 μg/l	Stored at 4°C	7 days
Group I	BHC-Alpha	0.010		
Base-Neutral	BHC-Beta	0.010		
Organics	BHC-Delta	0.01		
	BHC-Gamma (Lindane)	0.010		
	DDD (or TDE)	0.010		
	DDE (degradate of DDT)	0.010		
	DDT	0.025		
	Dieldrin	0.010		
	Endosulfan I	0.010		
	Endosulfan II	0.010		
	Endosulfan Sulfate	0.010		
	Endrin	0.010		
	Endrin Aldehyde	0.02		
	Heptachlor	0.010		
	Heptachlor Epoxide	0.010		
	Methoxychlor	0.100		
	Diclofop (Hoelon)	1.00		
	Toxaphene	1.0		
	Chlordane (gamma)	0.010		
	Chlordane (alpha)	0.010		
	trans-Nonachlor	0.010		
	Endrin Ketone	0.025		
	Alachlor	0.200		
	Chlorpyrifos	1.00		
	Diazinon	0.10		
	Malathion	0.040		
	Ethyl Parathion	0.450		
	Methyl Parathion	0.450		
	Fenvalerate	0.400		
	Cyanazine	0.050		
	Triallate (Fargo)	0.010		
	Trifluralin (Treflan)	0.010		
	Simazine	0.450		
	Ethylfluralin	0.010		
	Atrazine	0.250		
	Pendimethalin (Prowl)	0.010		
	Metribuzin	0.020		
	Metolachlor	0.080		
Group II	2,4-D	0.10 μg/l	Stored at 4°C	14 days
Chlorinated	Dicamba	0.10		
Herbicides	Dinoseb	0.20		
	MCPA	50.0		
	Picloram (Tordon)	0.10		
	2,4,5-T	0.15		
	2,4,5-TP (Silvex)	0.20		
	Pentachlorophenol	0.04		
	Acifluorfen	0.05		
	3,5 Dichlorobenzoic Acid	0.05		
	Bromoxynil	0.10		
	Bentazon	0.500		
	Dichlorprop	0.200		
Group III	Aldicarb	0.500 μg/l	1.33 ml carbamate buffer (76% water, 13.3% mono-chloroacetic acid, 5.6% acetic acid, 5.1% potassium hydroxide) to pH of 3.1 and stored between 8 and 25°C	28 days
Carbamates	Aldicarb Sulfoxide	0.50		
	Aldicarb Sulfone	0.50		
	Oxamyl	0.50		
	Carbofuran	0.50		
	3-Hydroxycarbofuran	0.500		
	Methomyl	0.500		
	Carbaryl	0.50		

TABLE 2 (continued)
Summary of Analytical Parameters

Analyte Group	Parameter Analyzed	NDDoH, DC Quantification Limit*	Sample Preservation	Holding Time
Minerals	Chloride	1.0 mg/l	Stored at 4°C	14-28 days, varies with parameter
	Fluoride	0.01		
	Sulfate	3.0		
	Carbonate (CO3)	1.0		
	Bicarbonate (HCO3)	1.0		
	Hydroxide (OH)	1.0		
	Total Alkalinity	2.0		
	Total Hardness			
	TDS			
	Laboratory Conductivity			
	Laboratory pH			
	Percent Sodium			
	Sodium Adsorption Ratio			
	Turbidity			
ICP Metals	Sodium	0.1 mg/l	2 ml nitric acid to pH 2 and stored at 4°C	6 months
	Magnesium	0.1		
	Potassium	1.0		
	Calcium	0.030		
	Manganese	0.002		
	Iron	0.007		
Nitrate	Nitrate plus Nitrite	0.05 mg/l (N)	2 ml sulfuric acid to pH 2 and stored at 4°C	28 days

*Quanitification limits for 1 full liter of clean sample.

Significance of Selected Constituents

Interpretation of water quality depends upon many factors, including the intended use of the water. Several water-quality parameters may be detrimental to health or may cause undesirable aesthetic effects that may be considered unsatisfactory to some, while others may see little or no adverse effect for nearly all uses. In view of possible adverse and/or undesirable effects, the U.S. EPA has established drinking water regulations for concentrations of certain elements for water delivered to users of a public water system. These standards are classified as either primary or secondary drinking water regulations. Primary drinking water regulations are federally enforceable regulations for specific contaminants that are potentially harmful to human health and are defined by a Maximum Contaminant Level (MCL). Although MCLs are not enforced for private water supplies, they sometimes are applied as a cleanup goal when remediation of contaminated groundwater is needed. Secondary drinking water regulations vary from state to state and are not federally enforceable. In contrast to the primary regulations, the secondary regulations are defined by Secondary Maximum Contaminant Levels (SMCL) and are designed to protect public welfare. SMCLs are only recommended limits, and North Dakota public water systems are not required to comply with them.

Of the general chemistry parameters included in primary drinking water regulations, nitrate is of primary concern. Health effects associated with drinking nitrate-contaminated water include methemoglobinemia, commonly called "blue baby syndrome," in infants. The MCL for nitrate plus nitrite as nitrogen (N), hereinafter referred to as nitrate, is 10 mg/l. The potential health effects of nitrates are discussed in detail in Appendix E, the Health Advisory section.

Fluoride also is included in the primary drinking water regulations. Most fluoride compounds have a low solubility; therefore, fluoride usually occurs only in small amounts in natural water. Many municipal water systems add fluoride to their drinking water. Within certain limits, fluoride in drinking water has been shown to reduce the formation of cavities in children. Optimum fluoride concentrations are region-specific and are dependent upon the annual average of maximum daily air temperatures. An excess of fluoride may produce skeletal damage and dental fluorosis (a brownish discoloration of the teeth). The MCL for fluoride has been set at 4 mg/l; however, the SMCL is 2 mg/l. Some groundwater in North Dakota has naturally occurring fluoride concentrations that exceed the MCL.

The chemical constituents included under the secondary drinking water regulations of interest for this report include iron, manganese, sulfate and chloride and the physical properties of hardness and Total Dissolved Solids (TDS). Although generally not a health concern, elevated concentrations of these constituents may cause unpleasant side effects and/or aesthetic qualities.

Although high concentrations of iron and manganese do not appear to present a health hazard, concentrations greater than the recommended limits may cause rust, brown or black stains on laundry, plumbing fixtures, sinks and utensils. A metallic taste may be present, and the elements may affect the taste of beverages made from the water. The SMCL for iron is 0.3 mg/l, and 0.05 mg/l for manganese.

Water containing high levels of sulfate may have a laxative effect on people unaccustomed to the water. These effects vary with the individual and appear to last only until one becomes accustomed to drinking the water. High sulfate content also affects the taste of water and will form a hard scale in boilers and heat exchangers. For these reasons, the SMCL is 250 mg/l.

High concentrations of chloride may result in an objectionable salty taste in water and the corrosion of plumbing in the hot water system. Water high in chloride also may produce a laxative effect. An SMCL of 250 mg/l has been recommended for chloride, although at this level few people will notice a salty taste. Higher concentrations do not appear to cause adverse health effects. An increase in the normal chloride content of water may indicate possible contamination from human sewage, feedlots or industrial wastes.

The TDS content of water is a measure of the total quantity of mineral matter present. Generally, the more highly mineralized the water, the more distinctive its taste. Water high in minerals also may cause plumbing and appliances to deteriorate. It is recommended that water containing more than 500 mg/l dissolved solids not be used if other less-mineralized supplies are available. This does not mean, however, that water containing more than 500 mg/l concentration of TDS is unusable. Exclusive of most treated public supplies, the Missouri River, a few fresh lakes, and scattered wells, very few water supplies in North Dakota contain less than the SMCL of 500 mg/l. Conductivity, closely related to the TDS content of water, is a measure of the conductance of water to an electrical current. Conductivity is reported as micromhos per centimeter (μmhos/cm). TDS, in mg/l, is approximately 70 percent of the conductivity.

Hardness also is related to the TDS, and, as used in this report, refers to calcium and magnesium hardness. Hard water has no known adverse health effects and may be more palatable than soft water. Hard water is primarily of concern because it requires more soap for effective cleaning; forms scum and curd; causes yellowing of fabrics; toughens vegetables cooked in the water; and forms scales in boilers, water heaters, pipes, and cooking utensils. Based on the U.S. Geological Survey classification (Klausing, 1979), water with a hardness of less than 60 mg/l (measured as calcium carbonate, $CaCO_3$) is considered soft, 61 to 120 mg/l is moderately hard, 121 to 180 mg/l is hard, and more than 180 mg/l is very hard. According to this classification, the hardness of good quality water should not exceed 270 mg/l. Because North Dakota groundwater is typically more mineralized than groundwater from other parts of the United States, the NDDoH-

DC uses a hardness classification that is tailored to North Dakota groundwater. The NDDoH-DC classification provides an interpretation of hardness relative to North Dakota groundwater, as follows: less than 75 mg/l (measured as calcium carbonate, $CaCO_3$) is considered low hardness, 76 to 150 mg/l is fairly low, 151 to 225 mg/l is satisfactory, 226 to 325 mg/l is average, 326 to 450 mg/l is high, and more than 450 mg/l is very high. The interpretation of hardness for groundwater samples collected for the North Dakota Groundwater Monitoring Program is based upon the NDDoH-DC hardness classification. Water softer than 30 to 50 mg/l may be corrosive to piping, depending upon other factors such as pH, alkalinity, temperature and dissolved-oxygen content.

There is no MCL or SMCL for sodium; however, high sodium content in water may be a concern for those people who must limit their dietary intake of sodium. The contribution of sodium in drinking water is normally small compared to other sources, such as consumption of sodium chloride, or table salt. A standard for public water supplies of no more than 100 mg/l sodium has been suggested to ensure that the water supply adds no more than 10 percent of the average person's total sodium intake, or an even more conservative standard of 20 mg/l, to protect heart and kidney patients. High concentrations of sodium will reduce the suitability of water for irrigation or for watering house plants. High concentrations of sodium in water may alter the soil chemistry and physical properties, possibly creating deleterious conditions for plant growth. Softening water by ion exchange or lime-soda ash processes will increase the sodium content.

Groundwater types, such as calcium bicarbonate and sodium chloride-bicarbonate, are classified based upon chemical analyses and represent the predominant cation (sodium, calcium or magnesium) and anion (bicarbonate, sulfate or chloride) expressed in milliequivalents per liter. When two or more cations or anions are present in nearly equal concentrations, it is referred to as a mixed chemical type.

MONITORING RESULTS

A total of 214 wells from all 11 aquifers were sampled for general cation and anion chemistry, total nitrate plus nitrite, and 60 selected pesticides and pesticide degradation products. The NDDoH-DC laboratory performed the analyses for all samples.

Nineteen wells, or approximately 9 percent of the wells sampled from the 11 aquifers, contained detectable concentrations of at least one pesticide. The Elk Valley aquifer had eight wells with pesticide detections, the Lake Souris and New Rockford aquifers each had three wells with pesticide detections, the Karlsruhe and Strawberry Lake aquifers each had two wells with pesticide detections, and the Fordville aquifer had one well with a pesticide detection. Table 3 lists all detections of pesticides, including the results of follow-up sampling.

Seven pesticide compounds were positively identified by laboratory analysis: bentazon, 2,4-D, endrin, 3-hydroxycarbofuran, methomyl, picloram.and triallate (Fargo). Picloram was the only pesticide confirmed in follow-up samples. None of the pesticides were detected at concentrations above their respective HAL or MCL. The highest concentration of a detected pesticide, both numerically and relative to a health-based standard, was of bentazon at 14.0 μg/l, or 70 percent of the HAL. There were two detections of endrin at 1.1 percent of the MCL, and one of methomyl at 1.18 percent of the HAL. All of the other detections were less than 1 percent of the MCL or HAL. A discussion of the pesticide detections in each well follows in sections addressing individual aquifers.

Fifty-one wells, or 24 percent of the 214 wells sampled, had nitrate concentrations greater than the detection limit of 0.05 mg/l (N) in at least one sample collected. Approximately one-third of the samples with detectable nitrate were at trace levels near the detection limit. Samples from 15 wells, or 7 percent of the total wells sampled, were greater than the 10 mg/l (N) MCL. A discussion of the nitrate detections in each well that exceeded the MCL follows in sections addressing individual aquifers.

TABLE 3
Summary of Pesticide-Detection Data
For All Aquifers Sampled in 1998

LOCATION/ SAMPLE WELL ID NUM.	AQUIFER	DATE	CHEMICAL DETECTED	HAL* or MCL(ug/l)	DETECTED CONC.(ug/l)	% of HAL or MCL	TYPE
15005406CCC	ELK VALLEY	06/09/98	Picloram	500.000	1.050	0.210	R
15005406CCC	ELK VALLEY	06/09/98	Picloram	500.000	1.190	0.238	D
15005406CCC	ELK VALLEY	08/10/99	Picloram	500.000	1.960	0.392	R
15005406CCC	ELK VALLEY	08/10/99	Picloram	500.000	2.010	0.402	D
15005525AAA	ELK VALLEY	06/10/98	Picloram	500.000	0.320	0.064	R
15005525AAA	ELK VALLEY	08/10/99	Picloram	500.000	0.310	0.062	R
15105419CCC	ELK VALLEY	06/17/98	Picloram	500.000	0.600	0.120	R
15105419CCC	ELK VALLEY	08/10/99	Picloram	500.000	0.600	0.120	R
15105431BBB	ELK VALLEY	06/18/98	Picloram	500.000	0.400	0.080	R
15105431BBB	ELK VALLEY	06/18/98	Picloram	500.000	0.450	0.090	D
15105431BBB	ELK VALLEY	08/10/99	Picloram	500.000	1.960	0.392	R
15105431BBB	ELK VALLEY	08/10/99	Picloram	500.000	2.400	0.480	D
15105501ADD	ELK VALLEY	06/23/98	Picloram	500.000	0.350	0.070	R
15105501ADD	ELK VALLEY	08/10/99	None				R
15105524AAA	ELK VALLEY	06/16/98	Picloram	500.000	0.350	0.070	R
15205521DDD	ELK VALLEY	06/03/98	Picloram	500.000	0.430	0.086	R
15205521DDD	ELK VALLEY	06/03/98	Bentazon	20.000*	14.000	70.000	R
15405625AAA	ELK VALLEY	06/15/98	Triallate	none	0.011		R
15505625BBB	FORDVILLE	06/23/98	3-Hydroxycarbofuran	none	0.638		R
15505625BBB	FORDVILLE	08/10/99	None				R
15307706DCC	KARLSRUHE	10/28/98	Endrin	2.000	0.013	0.650	D
15307706DCC	KARLSRUHE	08/18/99	None				R
15407826DAD3	KARLSRUHE	10/27/98	Endrin	2.000	0.022	1.100	R
15407826DAD3	KARLSRUHE	08/24/99	None				R
15407622DDA	LAKE SOURIS	07/14/98	Picloram	500.000	0.350	0.070	R
15807635CCC	LAKE SOURIS	08/17/99	Picloram	500.000	0.090	0.018	R
15907524BBB	LAKE SOURIS	08/17/99	Picloram	500.000	0.440	0.088	R
15407729DDA	NEW ROCKFORD	07/07/98	Methomyl	200.000*	2.360	1.180	R
15407729DDA	NEW ROCKFORD	08/24/99	None				R
15407730DDD2	NEW ROCKFORD	07/07/98	Methomyl	200.000*	1.450	0.725	R
15407730DDD2	NEW ROCKFORD	08/24/99	None				R
15407732BCC1	NEW ROCKFORD	07/01/98	2,4-D	70.000	0.250	0.357	R
15407732BCC1	NEW ROCKFORD	08/24/99	None				R
15008011CDC	STRAWBERRY LAKE	08/13/98	Endrin	2.000	0.022	1.100	D
15008011CDC	STRAWBERRY LAKE	08/23/99	None				R
15008023CCC	STRAWBERRY LAKE	08/13/98	Endrin	2.000	0.014	0.700	R
15008023CCC	STRAWBERRY LAKE	08/23/99	None				R

Sample Type: R = Regular Sample; D = Duplicate Sample; B = Blank Sample

Complete general inorganic chemical results, including nitrates, are listed for each aquifer in Appendix B. Also included with the analyses are the minimum, maximum, mean, median and standard deviation values for each parameter. Aquifer maps showing the sample locations are found in Appendix C. Descriptions of the characteristics and possible health effects of the detected pesticides and nitrates are found in Appendix E.

Denbigh Aquifer

Six samples were collected from six wells in the Denbigh aquifer. The water in the Denbigh aquifer is a calcium bicarbonate type. The samples were very high in iron and manganese and relatively low in dissolved solids, sulfate and sodium. Median hardness was average at 275 mg/l as $CaCO_3$.

There were no pesticide or nitrate detections in the samples from the Denbigh aquifer.

Resampling aquifers on a five-year cycle through the monitoring program provides an opportunity to assess the temporal variability of pesticide and nitrate detections in individual wells. In 1993, 10 samples from eight wells were collected in the Denbigh aquifer. Picloram was detected in two wells and confirmed in one of the wells upon resampling. Three wells contained detectable nitrate concentrations, all below 1.0 mg/l (N). Unfortunately, only one of the wells sampled in the Denbigh aquifer in 1993 was able to be sampled in 1998. No pesticides or nitrates were detected in the well either year.

Elk Valley Aquifer

A total of 88 samples were collected from 83 wells in the Elk Valley aquifer. The water from the aquifer is of relatively good chemical quality and generally a calcium bicarbonate type (Kelly and Paulson, 1970). On average, it is high in iron and manganese and within the recommended levels for sodium, chloride, TDS and sulfates. Eighteen of the wells did exceed the recommended levels for both sulfates and TDS. Median hardness was high at 401 mg/l as $CaCO_3$.

Pesticides were detected in samples from eight wells in the Elk Valley aquifer. Six of these wells were located in the same roadside ditch. Figure C-4 shows the locations of the wells relative to one another. In all six samples, picloram was the pesticide detected. Picloram, trade name Tordon, is often used for controlling leafy spurge in roadside ditches.

In the initial sample, well 15005406CCC had a picloram concentration of 1.05 μg/l, or 0.21 percent of the 500 μg/l MCL. The picloram concentration in the resample was 1.96 μg/l. No pesticides were detected in a sample collected from this well in 1993. This well is a two-inch-diameter monitoring well constructed of PVC. It is screened from 30 to 35 feet and had a water level at sampling time of approximately 2 feet below the ground surface. The well is located in a roadside ditch near a culvert and within 100 feet of crop land.

Well 15005525AAA had a detection of picloram at a concentration of 0.32 μg/l. In a follow-up sample, it had a concentration of 0.31 μg/l. These figures represent 0.064 percent and 0.062 percent of the MCL, respectively. A sample collected from this well in 1993 had a picloram concentration of 0.69 μg/l. In the follow-up sample, picloram again was detected, at a concentration of 0.1 μg/l. This well is a 2-inch-diameter monitoring well screened 24 to 29 feet below the surface. It had a water level of about 4.5 feet below ground surface when the sample was taken. The well is located in a road ditch, near small grains and row crops.

Well 15105419CCC had picloram detections of 0.60 μg/l, or 0.12 percent of the MCL, in both the initial and follow-up samples. This well is a 2-inch-diameter monitoring well screened from 30 to 35 feet. It is located in a roadside ditch within 100 feet of crop land. This well was not sampled prior to the 1998 sampling period.

Monitoring well 15105431BBB had picloram detections in both the regular and duplicate sample at concentrations of 0.40 and 0.45 μg/l, respectively. In follow-up sampling, both a regular and a duplicate sample were again collected from the well. The picloram concentration in the regular sample was 1.96 μg/l, and in the duplicate sample, 2.4 μg/l. In 1993 the initial and follow-up samples contained concentrations of 1.87 μg/l and 1.0 μg/l, respectively. Lower detections in the initial sample taken in 1998 may be attributable to unacceptable lab QA/QC. This well is a 2-inch-diameter well constructed of PVC and screened from 28 to33 feet. It is located in a ditch near row crops and small grains.

Well 15105501ADD had an initial picloram detection of 0.35 μg/l. No pesticides were detected in the follow-up sample. The initial detection may have been a false positive reading, since there were some concerns with lab QA/QC. This is a private domestic well. It is 4 inches in diameter, constructed of PVC and screened from 20 to 25 feet. The well is located in the backyard of the residence and within 100 feet to one-eighth mile of a septic system.

Monitoring well 15105524AAA had a detection of picloram at a concentration of 0.35 μg/l, or 0.07 percent of the MCL. Picloram concentrations ranged from 0.18 to 0.38 μg/l in samples collected from the well in the 1993 monitoring period. The well is 2 inches in diameter, constructed of PVC and screened from 28 to 33 feet. It had a water-level measurement of 8.5 feet below the ground surface when the sample was collected. The primary location of this well is in a roadside ditch and within 100 feet of row crops.

Two pesticides were detected in monitoring well 15205521DDD. Picloram was detected at a concentration of 0.43 μg/l, and bentazon was detected at 14.0 μg/l. The concentration of bentazon is 70 percent of the HAL, set at 20 μg/l. These results were not able to be confirmed with a follow-up sample, nor was this well included in the 1993 monitoring. This well is located in a roadside ditch near a farmyard. The well is 2 inches in diameter, constructed of PVC and screened from 33 to 38 feet. The water level at the time the well was sampled was about 7 feet below the surface. The well is located within one-eighth mile of row crops, a septic system and above-ground petroleum storage tanks.

Well 15405625AAA had a detection of triallate at a concentration of 0.011 μg/l. Currently, there are no MCLs or HALs set for triallate. There were no pesticide detections in previous samples collected from the well in 1993. This well is a 2-inch-diameter monitoring well constructed of PVC and screened from 50 to 55 feet. When the well was sampled, it had a water level of about 3.5 feet below the ground surface. The primary setting of the well is CRP land; the well also is located near row crops and within 100 feet of surface water.

In all, three of the wells in the Elk Valley aquifer with pesticide detections in 1993 also had pesticide detections in 1998. Table 4 lists the wells with pesticide detections in both years and the detected concentrations.

TABLE 4
Summary of Wells in the Elk Valley Aquifer
With Pesticide Detections in Both 1993 and 1998

LOCATION/ WELL ID NUM.	DATE	CHEMICAL DETECTED	DETECTED CONC. (Ug/l)	% of HAL or MCL	SAMPLE TYPE
15005525CCC	06/07/93	Picloram	0.690	0.138	R
15005525CCC	05/10/94	Picloram	0.100	0.020	R
15005525CCC	06/10/98	Picloram	0.320	0.064	R
15005525CCC	08/10/99	Picloram	0.310	0.062	R
15105431BBB	06/08/93	Picloram	1.870	0.374	R
15105431BBB	05/12/94	Picloram	1.000	0.200	R
15105431BBB	06/18/98	Picloram	0.400	0.080	R
15105431BBB	06/18/98	Picloram	0.450	0.090	D
15105431BBB	08/10/99	Picloram	1.960	0.392	R
15105431BBB	08/10/99	Picloram	2.400	0.480	D
15105524AAA	06/22/93	Picloram	0.290	0.058	D
15105524AAA	06/22/93	Picloram	0.380	0.076	R
15105524AAA	05/10/94	Picloram	0.180	0.036	R
15105524AAA	06/16/98	Picloram	0.350	0.070	R

R = Regular Sample; D = Duplicate Sample.

Seventeen wells, or about 21 percent of the total wells sampled in the Elk Valley aquifer, contained detectable nitrate concentrations. Four of the wells, about 5 percent, had concentrations equal to or greater than the MCL of 10 mg/l (N). All four wells with elevated nitrate concentrations were 2-inch-diameter, PVC monitoring wells. Three of these wells – 15005416CBC2, 15105503BBB2 and 15105511DCD2 -- were installed by the Environmental Energy and Research Center (EERC) and the State Water Commission in 1997. They are shallow wells, less than 20 feet deep and located within 100 feet of row crops. The nitrate concentrations in these wells were 12.8, 23.7 and 62.1 mg/l (N), respectively. The fourth well, 15205521DDD, is a State Water Commission well installed in 1990. It had a nitrate concentration of 54.4 mg/l (N) and is described above, because it also had a pesticide detection.

Figure 3 compares percentages of wells with nitrate detections in the Elk Valley aquifer for the years 1993 and 1998. In 1993, 17 wells, or 30 percent of the wells sampled in the Elk Valley aquifer, contained nitrate concentrations. One sample, or 2 percent, contained a nitrate concentration in excess of 10 mg/l (N) MCL. In all, 45 of the 56 wells initially sampled in the Elk Valley aquifer in 1993 were resampled in 1998. As shown in Figure 3, the overall percentage of wells with nitrate detections decreased from 1993 to 1998. The most notable change was that there was an increase in the percentage of wells with intermediate nitrate detections. Ten of the wells with nitrate detections in 1993 were resampled in 1998. Concentrations increased in four of these wells and decreased in six wells. Five of the six wells decreased to non-detectable limits. Two wells that had nitrate detections in 1998 had no detections in 1993. Table 5 lists all 45 wells sampled in both years, along with the nitrate concentrations detected in each well.

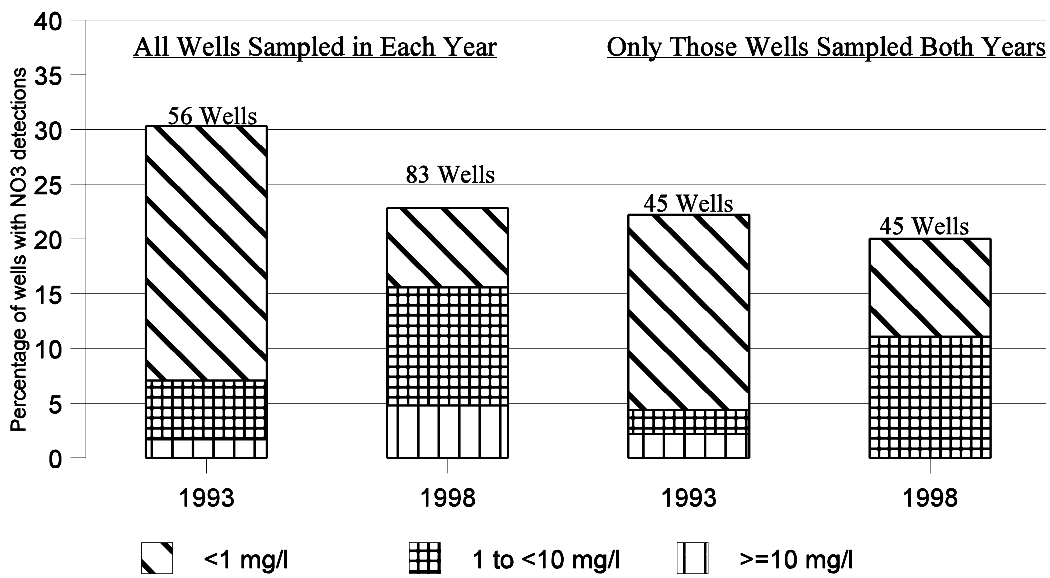

FIGURE 3. Graph of nitrate detections in the Elk Valley aquifer for the years 1993 and 1998

TABLE 5
Summary of Nitrate Concentrations
in the Wells in the Elk Valley Aquifer Sampled in Both 1993 and 1998
In milligrams per liter [mg/l] (N)

Well ID #		Type of Well	1993	1998
1.	149 054 03 AAA	Monitoring	ND	ND
2.	149 054 04 BBB	Monitoring	ND	ND
3.	150 054 01 AAA	Monitoring	ND	ND
4.	150 054 03 CDD2	Monitoring	ND	ND
5.	150 054 04 BBB	Monitoring	ND	ND
6.	150 054 06 CCC	Monitoring	ND	ND
7.	150 054 10 CCC	Monitoring	ND	ND
8.	150 054 11 CCC	Monitoring	ND	ND
9.	150 054 12 CCC	Monitoring	ND	ND
10.	150 054 22 DDD	Monitoring	ND	ND
11.	150 054 24 CCD	Domestic	0.01	ND
12.	150 055 13 AAA	Monitoring	ND	ND
13.	150 055 25 AAA	Monitoring	ND	ND
14.	151 054 07 BBB2	Monitoring	0.91	ND
15.	151 054 15 CDD	Monitoring	ND	ND
16.	151 054 19 DDD	Monitoring	ND	ND
17.	151 054 20 BBB	Monitoring	ND	ND
18.	151 054 21 DDD	Monitoring	ND	ND
19.	151 054 23 AAA	Monitoring	27.6	4.18
20.	151 054 26 BAB	Monitoring	ND	ND
21.	151 054 31 BBB	Monitoring	ND	ND
22.	151 054 36 CCC2	Monitoring	0.17	2.78
23.	151 055 04 AAA	Monitoring	ND	0.17
24.	151 055 15 AAA	Monitoring	ND	ND
25.	151 055 23 CCC	Monitoring	ND	ND
26.	151 055 24 AAA	Monitoring	ND	0.14

TABLE 5 (continued)
Summary of Nitrate Concentrations
in the Wells in the Elk Valley Aquifer Sampled in Both 1993 and 1998
In milligrams per liter [mg/l] (N)

Well ID #		Type of Well	1993	1998
27.	152 055 04 BBB	Monitoring	ND	ND
28.	152 055 10 DDD	Monitoring	ND	ND
29.	152 055 15 BBB	Monitoring	ND	ND
30.	152 055 16 DDD	Monitoring	ND	ND
31.	152 055 20 AAA	Monitoring	ND	ND
32.	152 055 22 DDD	Monitoring	ND	ND
33.	153 055 16 DAA	Monitoring	ND	ND
34.	153 055 30 AAA	Monitoring	ND	ND
35.	153 055 32 AAA	Monitoring	2.01	9.29
36.	153 055 34 BBB	Monitoring	ND	ND
37.	154 055 08 CCC	Monitoring	0.52	ND
38.	154 055 18 BBB	Monitoring	ND	ND
39.	154 055 28 CCC	Monitoring	ND	ND
40.	154 055 30 DDA2	Monitoring	0.42	6.62
41.	154 055 31 CCC	Monitoring	0.03	ND
42.	154 055 32 BBC2	Monitoring	0.09	1.90
43.	154 056 13 BBC	Monitoring	ND	ND
44.	154 056 23 DDD	Monitoring	0.03	ND
45.	154 056 25 AAA	Monitoring	ND	ND

ND = Not Detected

Fordville Aquifer

Eleven samples were collected from 10 wells in the Fordville aquifer. The water in the Fordville aquifer is generally a calcium bicarbonate type. It is low in sodium, sulfate, chloride and TDS and very high in iron and manganese. All 11 samples exceeded the recommended levels of iron and manganese, which are 0.3 and 0.05 mg/l, respectively. Iron concentrations ranged from 0.73

to163 mg/l and averaged 44.32 mg/l. The manganese concentrations ranged from 0.581 to 25.4 mg/l and averaged 5.4 mg/l. The median hardness was high at 351 mg/l as $CaCO_3$.

There was one well (10 percent) with a pesticide detection in the Fordville aquifer. Well 15505625BBB contained 3-hydroxycarbofuran at a concentration of 0.638 μg/l in the initial sample collected; however, no pesticides were detected in the well when the follow-up sample was collected 14 months later. There is no MCL or HAL for 3-hydroxycarbofuran. This well is a 2-inch diameter monitoring well with a depth of 30 feet and a screened interval of 25 to 30 feet. The water level in the well was approximately 21 feet below the surface. The primary setting of the well is on a roadside near pasture and hayland.

Three wells, or 30 percent of the wells sampled in the Fordville aquifer, contained detectable nitrate concentrations. Concentrations for all three wells were below the MCL of 10 mg/l (N) and ranged from 0.13 to 8.08 mg/l (N).

In 1993, six wells were sampled in the Fordville aquifer. Picloram was detected in one well (16.7 percent) and confirmed in follow-up sampling.

Nitrate plus nitrite was detected in three of the wells (50 percent) sampled in 1993. The nitrate concentration was greater than the MCL in one well – the well mentioned above with the picloram detection. None of the six wells sampled in 1993 were sampled in 1998, therefore a direct comparison of the wells cannot be made. However, in 1997 the NDDoH installed a well next to and at the same approximate depth as one of the wells sampled in 1993. The existing well was a 4-inch-diameter well; the well installed by the NDDoH was a 2-inch-diameter well. When the existing well was sampled in 1993, nitrate was detected at 2.07 mg/l. The newly-installed well was sampled in 1997 and in 1998 with nitrate detections of 12.8 and 8.08 mg/l, respectively. Overall, the pesticide and nitrate contamination in the Fordville aquifer appears to have remained about the same or decreased.

Inkster Aquifer

Eight samples were collected from eight wells in the Inkster aquifer. The water in the Inkster aquifer is generally a calcium bicarbonate type, high in iron and manganese and relatively low in sodium. Three wells exceeded the recommended levels for total dissolved solids. Median hardness was high at 327 mg/l as $CaCo_3$.

No pesticides were detected in the samples from the Inkster aquifer.

Samples taken from two wells, or 25 percent of the wells sampled in the Inkster aquifer, contained detectable levels of nitrate. The nitrate concentrations were 1.02 and 5.61 mg/l (N). Both wells were monitoring wells less than 6 inches in diameter constructed of PVC casing. The distance from the water table to the top of the screen in both wells was less than 10 feet.

Figure 4 compares percentages of wells with nitrate concentrations in the Inkster aquifer for the years 1993 and 1998. In 1993, one well, or 11 percent of the wells sampled in the Inkster aquifer, contained detectable nitrate. As shown in Figure 4, the overall percentage of wells with nitrate detections increased from 1993 to 1998; however, this can be attributed to only one additional well with a nitrate detection in 1998. Seven of the nine wells sampled in 1993 were resampled in 1998.

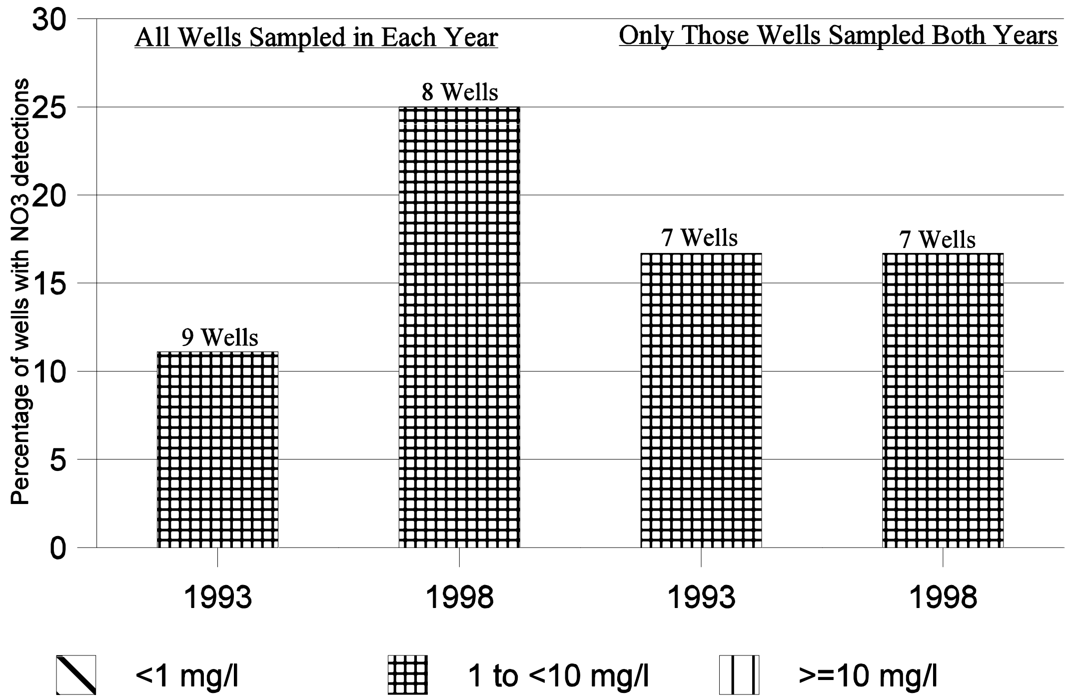

FIGURE 4. Graph of nitrate detections in the Inkster aquifer for the years 1993 and 1998

Table 6 lists the seven wells sampled in both years, along with the nitrate concentrations detected in the wells. The only well with a nitrate detection in 1993 also had nitrate detected in 1998. The concentration decreased in the well from 8.9 mg/l (N) to 5.61 mg/l (N).

TABLE 6
Summary of Nitrate Concentrations
in the Wells in the Inkster Aquifer Sampled in Both 1993 and 1998
In milligrams per liter [mg/l] (N)

Well ID #	Type of Well	1993	1998
1. 153 055 14 DCC	Monitoring	ND	ND
2. 154 055 09 DDD	Monitoring	ND	ND
3. 154 055 10 CDCDC	Monitoring	ND	ND
4. 154 055 15 ADAA	Monitoring	8.90	5.61
5. 154 055 22 BAA	Monitoring	ND	ND
6. 154 055 23 DBB2	Monitoring	ND	ND
7. 154 055 28 DDD	Monitoring	ND	ND

ND = Not Detected

Karlsruhe and New Rockford Aquifers

Because of their proximity to one another, their probable hydrologic connection in at least one area, and the incidences and locations of pesticide and, especially, nitrate detections in the two aquifers, the monitoring results of the Karlsruhe and New Rockford aquifers will be discussed together.

Twenty-three samples were collected from 19 wells in the Karlsruhe aquifer. The water in the Karlsruhe aquifer is generally a calcium bicarbonate-type water, although a few water chemistries appear to be a sodium bicarbonate or mixed calcium-sodium bicarbonate type. In general, the samples were low in sodium and chloride and high in iron and manganese. Almost one-half the samples were above the recommended limit of 500 mg/l total dissolved solids. Median hardness was high at 365 mg/l as $CaCO_3$.

Pesticides were detected in samples from two wells in the Karlsruhe aquifer. Endrin was detected in a duplicate sample from well 15307706DCC at a concentration of 0.013 μg/l, or 0.65 percent of the MCL, set at 2.0 μg/l. No pesticides were detected in the regular sample from the well or in follow-up confirmation resampling. This is a 2-inch-diameter monitoring well constructed of PVC casing, with a screened interval of 8.5 to 18.5 feet. At the time the initial sample was collected from the well, the water level was a little over 5 feet below ground surface.

Endrin was also detected in well 15407826DAD3 at a concentration of 0.022 μg/l, or 1.1 percent of the MCL. As with the preceding well, no pesticides were detected in this well in follow-up resampling. This well is also a 2-inch-diameter, PVC monitoring well, screened from 50 to 60 feet, with a water level approximately 28 feet below ground surface. Both wells with pesticide detections were installed by the NDDoH in late fall 1998. The wells were sampled shortly after they were installed, but by the time the results of the analyses were received it was too late to resample the wells that year. Follow-up confirmation sampling was performed on the wells after the regular monitoring season in the summer of 1999. Both wells were in a roadside/field setting and near row crops being irrigated at the time.

Ten wells, or 53 percent of the wells sampled in the Karlsruhe aquifer, contained detectable nitrate concentrations. Seven of the wells, about 37 percent, had concentrations equal to or greater than the MCL of 10 mg/l (N). Two of the wells, 15407731ABB2 and 15407731ABB3, are a nested pair, 33 and 48.5 feet deep, respectively. The nitrate concentration in the shallower well was 42.7 mg/l (N), and in the deeper well, 44.6 mg/l (N). The other wells with nitrates equal to or greater than 10 mg/l (N) and their respective concentrations are 15407732CBC3, 30.7 mg/l (N); 15407825CDD, 41.3 mg/l (N); 15407826CDD, 74.3 mg/l; 15407826DAD3, 20.1 mg/l (N) in the initial sample, and 18.9 mg/l (N) in a follow-up sample (this well was one of the two wells with pesticide detections); and 15407827DDA2, which was sampled on two occasions. When the well was initially sampled, both a regular and a duplicate sample were collected, with respective nitrate concentrations of 59.3 mg/l (N) and 66.5 mg/l (N). The nitrate concentration in the resample was 45.7 mg/l (N).

All of the seven wells with elevated nitrate concentrations were 2-inch-diameter, PVC-cased monitoring wells. Well depths in the seven wells ranged from 31 to 60 feet; water levels were from approximately 19 to 34 feet below ground surface. All seven wells were within one-eighth of a mile -- most within 100 feet -- of row crops that were being irrigated. After row crops, hayland was the most often reported land use near wells with nitrate detections. All of the wells were located on a roadside. Another factor which seemed to show a clear relationship to nitrate detections was distance from the water table to the top of the screen. In the Karlsruhe aquifer, almost 67 percent of nitrate detections occurred in wells in which the distance from the water table to the top of the screen was less than 10 feet. The wells in the Karlsruhe aquifer did not exhibit the usual relationship of decreasing detections/concentrations with increasing depth. The fact that most of the nitrate detections and all but one of the high-concentration detections occurred in wells in the intermediate depth category (20 to 50 feet) instead of the shallow depth category (less than 20 feet) may simply be due to the availability of more wells to sample at the intermediate depth. However, the other high-concentration nitrate detection occurred in a well 60 feet deep, and the higher concentration in the deeper well of the nested pair mentioned above, along with such a large percentage of wells with high nitrate concentrations, may be an indication of a relationship between the nitrates and some other factor, in this case the extensive irrigation in the area. Figure C-2 illustrates the location of pesticide and nitrate detections in relation to irrigation wells in the Karlsruhe and New Rockford aquifers.

Sixteen samples were collected from 13 wells in the New Rockford aquifer. Because the New Rockford aquifer is relatively deep and confined for much of its length and wells are generally deeper than 100 feet, the wells that were sampled for the monitoring program were primarily in the northwestern part of the aquifer where the aquifer is shallowest. About one-half of the samples were a calcium bicarbonate type water, and the other half were a sodium bicarbonate type. In general, the water is high in iron and manganese and within the recommended limits for chloride and sulfate. Approximately one-third of the samples exceeded the recommended limit for total dissolved solids. The median hardness was average at 266 mg/l as $CaCO_3$.

Pesticides were detected in samples from three wells in the New Rockford aquifer. Well 15407729DDA contained methomyl at a concentration of 2.36 μg/l, or 1.18 percent of the HAL set at 200 μg/l. No pesticides were detected in a follow-up sample collected from the well. This well is a 2-inch-diameter monitoring well constructed of PVC casing. The well is screened from 73 to 78 feet, and the water level in the well was approximately 35 feet below ground surface. The well is located near a farmyard, pasture and small grains cropping.

Methomyl was also detected in well 15407730DDD2 at a concentration of 1.45μg/l, or 0.725 percent of the HAL. Pesticides were not detected in the follow-up sample from the well. The well is a 1.25-inch-diameter PVC monitoring well screened from 61 to 66 feet with a water level about 14 feet below ground surface. The well is located on a roadside near irrigation, row crops, hayland, and CRP.

Well 15407732BCC1 had a detection of 2,4-D in the initial sample at a concentration of 0.25 μg/l, or 0.357 percent of the MCL, set at 70 μg/l. No pesticides were detected in the follow-up sample from this well, either. The well is a 1.25-inch-diameter steel monitoring well screened from 29 to 31 feet with a water level of about 20 feet below ground surface. It is located on a roadside and near irrigation and row crops.

Three wells, or 23 percent of the wells sampled in the New Rockford aquifer, contained detectable nitrate concentrations. Two of the wells, about 15 percent, had concentrations equal to or greater than the 10 mg/l (N) MCL. The two wells are a nested pair. The shallower of the two wells, 15407732BCC1, also had the detection of 2,4-D and is discussed above. When the initial sample was collected from the well, the concentration of nitrates detected was 4.06 mg/l (N); in the follow-up sample, the concentration was 33.8 mg/l (N). Well 15407732BCC3 is a 2-inch-diameter PVC monitoring well installed by the NDDoH in 1998. The well is screened from 35 to 45 feet, with a water level about 18 feet below ground surface. The nitrate concentration detected in the well was 30.8 mg/l (N).

As with the Karlsruhe aquifer, most pesticide and nitrate detections in the New Rockford aquifer are associated with a roadside/field general setting and near row crops and irrigation. CRP also was reported near many of these wells.

Lake Souris Aquifer

Thirty-three samples were collected from 33 wells in the Lake Souris aquifer in 1998. The water in the Lake Souris aquifer generally is a calcium bicarbonate type. In general, the water from the Lake Souris aquifer is low in sodium and sulfate and high in iron and manganese. Approximately one-fourth of the samples exceeded the recommended limit of 500 mg/l for total dissolved solids. Median hardness was average at 301 mg/l $CaCO_3$.

In 1998, the Lake Souris aquifer had three wells, about 9 percent, with detectable levels of pesticides. Two of the wells with pesticide detections, 15807635CCC and 15907524BBB, were monitoring wells installed by the NDDoH in December 1998, too late to sample because of winter conditions. These wells were not sampled for the first time until after the regular sampling season in 1999. By the time the analytical results were received, it was too late to do confirmation resampling and have the results included in this report. The third well with a pesticide detection, 15407622DDA, was also a monitoring well and could not be resampled because the trail providing access to the well was covered with water. The pesticide detected in all three wells was picloram, with concentrations ranging from 0.09 μg/l to 0.44 μg/l, or 0.018 to 0.088 percent of the MCL. All three wells were constructed of 2-inch-diameter PVC casing. Well depths ranged from 25 to 34 feet below ground surface, and the top of the screened intervals was from 15 to 29 feet below ground surface. The depth to water in the wells was 3 feet or less. Two of the wells were in or near a pasture and by a roadside. The general setting of the third well was near a pasture and a field; however, the well also is located along a roadside. All three wells were within one-eighth mile of surface water. None of the three wells with pesticide detections had nitrate detected.

Seven wells, about 21 percent, of the 33 wells sampled in the Lake Souris aquifer contained detectable concentrations of nitrate. The concentration in one well, which represents 3 percent of the total wells sampled in the aquifer, was above the 10 mg/l (N) MCL. The well, 15807723CBB, is used for domestic purposes and watering livestock. It is a 4-inch-diameter well constructed of PVC casing, with a screened interval of 18 to 35 feet below ground surface. The reported water level when the well was constructed was approximately 7 feet below ground surface. The well is located in a farmyard and within 100 feet of a feedlot and a pasture. The nitrate concentration detected in the well in 1998 was 15.2 mg/l (N); the well also was sampled in 1993, at which time the nitrate concentration in the well was 0.32 mg/l (N). Nitrate concentrations in the other wells ranged from 0.09 to 7.26 mg/L (N), with concentrations in four of the six wells less than 1 mg/l (N).

Only about one-half the wells sampled in the Lake Souris aquifer in 1993 could be sampled again in 1998. Some wells could not be reached because of wet conditions; some could not be found and presumably were either abandoned or accidentally destroyed; a few had missing caps or had sustained damage that compromised the integrity of the well; and in some instances, attempts to contact the landowner for permission to sample the well were unsuccessful. In all, nine of the 20 wells sampled in the Lake Souris aquifer in 1993 were sampled again in 1998. Figure 5 compares the percentages of nitrate detections in the Lake Souris aquifer for the years 1993 and 1998. The first two columns depict the percentages of wells with nitrate detections for all wells sampled for those years; the last two columns are a direct comparison of just the nine wells sampled in both years.

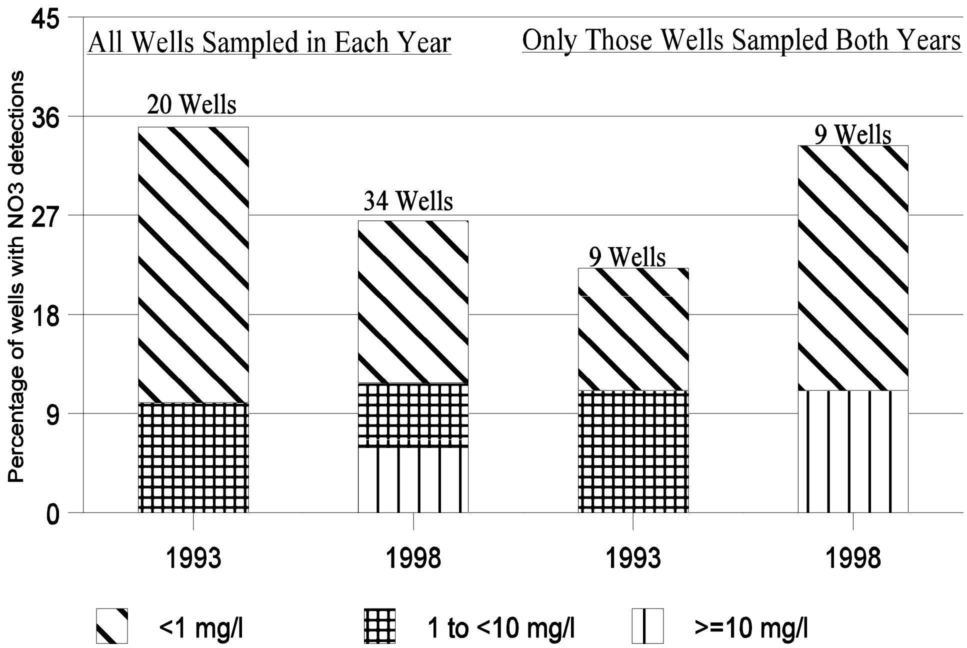

FIGURE 5. Graph of nitrate detections in the Lake Souris aquifer for the years 1993 and1998

In 1993, seven wells, or 35 percent of the 20 wells sampled in the Lake Souris aquifer, contained detectable levels of nitrates. All of the concentrations were below the 10 mg/l (N) MCL. As shown in Figure 5, the overall percentage of wells with nitrate detections decreased considerably from 1993 to 1998, even though more than one and one-half times more wells were sampled in the aquifer in 1998. When comparing only the nine wells sampled in both years, there appears to be a significant increase in nitrates in those wells. However, in 1993 only two of the nine wells had nitrate detections, and in 1998, three wells had nitrate detections, illustrating how rapidly percentages can change when comparing small numbers of wells. Of the two wells with nitrate detections in 1993, one decreased in concentration and the other, discussed above, increased from less than 1 mg/l to one and one-half times the MCL. Table 7 lists all nine wells sampled in the Lake Souris aquifer in both years, along with the nitrate concentrations detected in the wells.

TABLE 7
Summary of Nitrate Concentrations
in the Wells in the Lake Souris Aquifer Sampled in Both 1993 and 1998
In milligrams per liter [mg/l] (N)

Well ID #	Type of Well	1993	1998
1. 154 076 05BAB	Monitoring	ND	ND
2. 154 076 08 DDD	Monitoring	ND	ND
3. 154 077 11 BCC	Monitoring	1.25	0.12
4. 155 076 31 DCC	Monitoring	ND	ND
5. 155 077 34 DD	Livestock	ND	ND
6. 155 077 35 DCC	Monitoring	ND	0.09
7. 155 078 10 CBB	Domestic	ND	ND
8. 158 077 15 DCC	Domestic	ND	ND
9. 158 077 23 CBB	Domestic	0.32	15.2

ND = Not Detected

In 1993, picloram was detected in one well in the Lake Souris aquifer, 15407605BAB. This represents 5 percent of the total wells sampled in the aquifer that year. The detected concentration was right at the method quantification limit of 0.1 μg/l. No pesticides were detected in a duplicate sample collected at the same time, or in samples collected from the well on two separate occasions since, including the 1998 sample. This well is a monitoring well located in a pasture and roadside setting.

McVille Aquifer

Samples were collected from nine wells in the McVille aquifer. The water in the McVille aquifer is a calcium bicarbonate type high in iron and manganese, but within the recommended limits for sodium, sulfate and TDS. Median hardness was average at 308 mg/l as $CaCO_3$.

No pesticides were detected in the McVille aquifer.

Samples from three wells, about 33 percent, contained detectable levels of nitrate. The levels detected ranged from 0.6 mg/l (N) to 0.21 mg/l (N). This is well below the 10 mg/l (N) MCL.

Shell Valley Aquifer

Nineteen samples were collected from 19 wells in the Shell Valley aquifer in 1998. According to Randich and Kuzniar (1984), the water in the Shell Valley aquifer is a mixed type. In general, it is low in sodium, chloride and TDS, and high in iron, manganese and sulfate. Median hardness was average at 321 mg/l as $CaCo_3$.

No pesticides were detected in the samples from the Shell Valley aquifer.

Four wells, or 21 percent, of the 19 wells sampled in the Shell Valley aquifer contained detectable levels of nitrate. One well, 16007126AAA, had a concentration above the 10 mg/l (N) MCL. The well is a 1.25-inch-diameter monitoring well constructed of PVC casing, located within 100 feet of a pasture and CRP. The well is screened from 65 to 68 feet and had a water level of about 25 feet when the sample was taken. The nitrate concentration was 24 mg/l (N).

Figure 6 compares percentages of nitrate detections in the Shell Valley aquifer for the years 1993 and1998. The first two columns depict the percentages of nitrate detections for all wells sampled for those years, and the last two columns are a direct comparison of the seven wells sampled in both years.

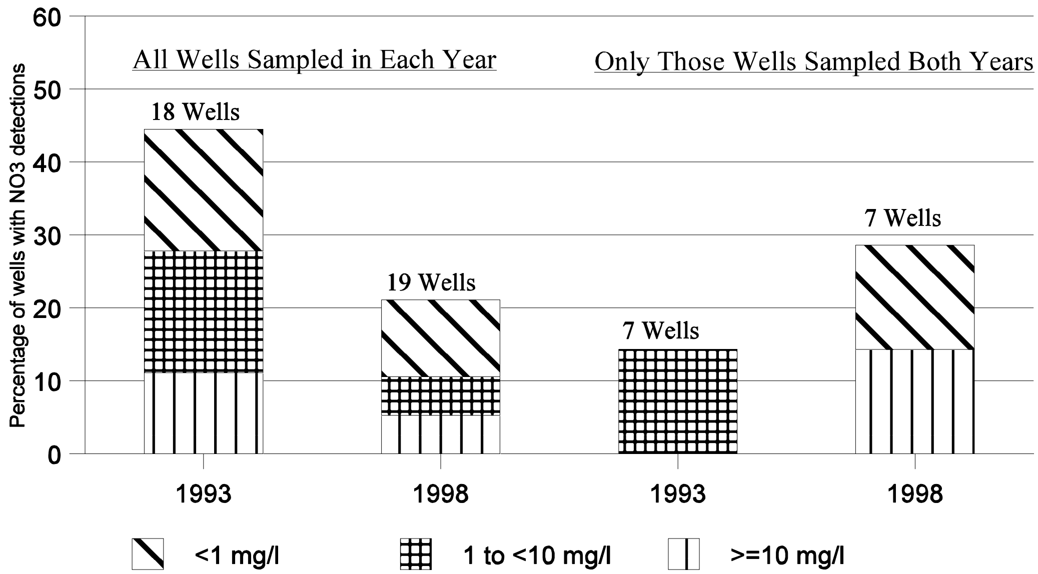

Figure 6. Graph of nitrate detections in the Shell Valley aquifer for the years 1993 and 1998

Overall, the percentage of wells with nitrate detections decreased in 1998. This may be due in part to the fact that only seven of the 18 wells sampled in 1993 were resampled in 1998. One of the seven wells, 16007126AAA, did not have a detection in 1993 but had a detected concentration of 24.0 mg/l (N) in 1998. Well 16107129DAD had a decreased nitrate concentration from 1.59 mg/l in 1993 to 0.59 mg/l in 1998. Table 8 lists all seven wells sampled in the Shell Valley aquifer in both years, along with the nitrate concentrations detected in the wells.

TABLE 8
Summary of Nitrate Concentrations
in the Wells in the Shell Valley Aquifer Sampled in Both 1993 and 1998
In milligrams per liter [mg/l] (N)

Well ID #	Type of Well	1993	1998
1. 160 071 07 AAA	Monitoring	ND	ND
2. 160 071 19 DDD	Monitoring	ND	ND
3. 160 071 26 AAA	Monitoring	ND	24.0
4. 160 071 29 CAB	Domestic	ND	ND
5. 161 071 16 CDD	Monitoring	ND	ND
6. 161 071 29 DAD	Monitoring	1.59	0.59
7. 161 072 35 CDC	Monitoring	ND	ND

ND = Not Detected

Strawberry Lake Aquifer

Eleven samples were collected from nine wells in the Strawberry Lake aquifer. The water is predominantly a calcium bicarbonate type, high in iron and manganese and low in sodium and chloride. A few samples were above the recommended limits for both sulfates and total dissolved solids. Median hardness was high at 399 mg/l as$CaCO_3$.

Pesticides were detected in samples from two wells in the Strawberry Lake aquifer. A duplicate sample from well 15008011CDC had a detectable concentration of endrin at 0.022 μg/l, or 1.1 percent of the MCL, set at 2.0 μg/l. Pesticides were not detected in either the regular sample collected at the same time or in a follow-up sample. This well is a 1.25-inch-diameter monitoring well constructed of PVC casing and screened from 78 to 83 feet. The water level in the well was approximately 50 feet below ground surface. The well was located near pasture, hayland, a field of small grains, and surface water consisting of small wetland areas in adjacent fields.

Endrin was also detected in the second well in the Strawberry Lake aquifer, 15008023CCC. The detected concentration was 0.014μg/l, or 0.7 percent of the MCL. No pesticides were detected in the follow-up sample collected from the well. The well is also a 1.25-inch-diameter, PVC monitoring well. It is screened from 58 to 63 feet, and the water level in the well at the times it was sampled was approximately 20 feet below ground surface. The well was located near a pasture, CRP land, and surface water consisting of nearby stock ponds and a small wetland area.

One well, approximately 11 percent, of the wells sampled in the Strawberry Lake aquifer contained a detectable concentration of nitrate. The concentration in the well was 0.75 mg/l (N). Because the more recent aquifers sampled are generally ranked lower in our Geographic Targeting System for vulnerability, sensitivity and risk, some of the previous relationships between nitrate detections and other factors are not as clear as seen with more vulnerable aquifers and, in some cases, do not apply at all. This is especially true with various well construction characteristics. For example, previous monitoring results have consistently shown a relationship between shallow wells – less than 20 feet deep – and nitrate detections. All nine wells sampled in the Strawberry Lake aquifer were more than 20 feet deep, and eight of the nine wells were more than 50 feet deep. Accordingly, the depth to the top of the screened interval is almost certainly going to be greater than in shallow wells. Therefore, the failure to demonstrate a relationship between nitrate detections and some of these factors is due to the fact that the aquifer is deeper and there are no shallow wells to sample.

Turtle Lake Aquifer

Only five wells were sampled in the Turtle Lake aquifer. The water in the Turtle Lake aquifer is a calcium bicarbonate type. It is high in sodium, sulfate, TDS, iron and manganese. The median hardness was average at 369 mg/l as $CaCO_3$.

No pesticides were detected in the Turtle Lake aquifer.

One well, or 20 percent, contained a detectable level of nitrate at a concentration of 3.11 mg/l (N), about one-third of the MCL.

Well Construction / Water Quality Relationships

Relationships between pesticide and nitrate detections and most well characteristics are difficult to define from these sample results. This is especially true for pesticides because of the very low overall percentage of detections in relation to the total sample population. When trying to relate well-construction characteristics to a small subset population of detections, percentages change rapidly and confidence levels are low. See Table 9 for a summary of statistics on well construction related to pesticide and nitrate plus nitrite detections in this survey. Appendix D contains these summary statistics for each aquifer.

In general, the depth of the well, the depth to the top of the screened interval and the distance from the water table to the top of the screen seemed to show a relationship to nitrate detections. The percentage of nitrate detections was greatest in wells that were less than 20 feet deep, in wells in which the top of the screened interval was less than 20 feet deep, and in wells in which the water table was less than 10 feet from the top of the screen. The percentage of nitrate detections generally decreased as well depth increased, as depth to the top of the screened interval increased, and as the distance from the water table to the top of the screen increased. The well-construction characteristics did not show any relationship to pesticide detections. This is probably due to the small number of pesticide detections in the sample set. The above findings are consistent with the results of the 1993 study, in which all three of the depth-related characteristics seemed to correlate well to nitrate plus nitrite detections.

The casing material, diameter of the well and well use could not be used to show a relationship to nitrate or pesticide detections. This is due to the fact that most of the wells sampled were monitoring wells less than 6 inches in diameter and constructed of PVC or ABS. These results are similar to those found in the 1993 sampling period.

TABLE 9
Pesticide and Nitrate Plus Nitrite Detections
Related to Well Construction
For All Aquifers Sampled in 1998

NUMBER OF DETECTIONS		#	PERCENT
Wells with only pesticide detections	:	15	7.0 %
Wells with only nitrate detections	:	47	22.0%
Wells with pesticide & nitrate detections	:	4	1.9 %
Wells with nitrate > 10 mg/L	:	15	7.0 %

Total number of wells in sample population : 214

AQUIFER	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
DENBIGH :	6	2.8	0	0.0	0	0.0
ELK VALLEY :	83	38.8	8	9.6	17	20.5
FORDVILLE :	10	4.7	1	10.0	3	30.0
INKSTER :	8	3.7	0	0.0	2	25.0
KARLSRUHE :	19	8.9	2	10.5	10	52.6
LAKE SOURIS :	33	15.4	3	9.1	7	21.2
MCVILLE :	9	4.2	0	0.0	3	33.3
NEW ROCKFORD :	13	6.1	3	23.1	3	23.1
SHELL VALLEY :	19	8.9	0	0.0	4	21.1
STRAWBERRY LAKE :	9	4.2	2	22.2	1	11.1
TURTLE LAKE :	5	2.3	0	0.0	1	20.0

DEPTH OF WELLS	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
< 20 Ft. :	24	11.2	1	4.2	15	62.5
20 - 50 Ft. :	132	61.7	12	9.1	28	21.2
> 50 Ft. :	56	26.5	6	10.7	7	12.5
Unknown :	2	0.9	0	0.0	1	50.0

DIAMETER OF WELL	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
< 6 in. :	205	95.8	19	9.3	48	23.4
6 - 18 in. :	6	2.8	0	0.0	2	33.3
> 18 in. :	1	0.5	0	0.0	0	0.0
Unknown :	2	0.9	0	0.0	1	50.0

CASING MATERIAL	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
Plastic(PVC or ABS) :	205	95.8	18	8.8	45	22.0
Concrete/Brick/Stone :	1	0.5	0	0.0	0	0.0
Metallic :	6	2.8	1	16.7	5	83.3
Other :	2	0.9	0	0.0	1	50.0

DEPTH TO TOP OF SCREENED INTERVAL	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
< 20 Ft. :	45	21.0	3	6.7	21	46.7
20 - 50 Ft. :	121	56.5	12	9.9	22	18.2
> 50 Ft. :	44	20.6	4	9.1	6	13.6
Unknown :	4	1.9	0	0.0	1	25.0

DISTANCE FROM WATER TABLE TO TOP OF SCREEN	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
< 10 Ft. :	53	24.8	3	5.7	36	67.9
10 - 30 Ft. :	87	40.7	10	11.5	8	9.2
> 30 Ft. :	54	25.2	4	7.4	2	3.7
Unknown :	20	9.3	2	10.0	5	25.0

TYPE OF WELL	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
Monitoring :	194	90.7	18	9.3	46	23.7
Private/Domestic :	14	6.5	1	7.1	3	21.4
Livestock :	2	0.9	0	0.0	0	0.0
Public Supply :	4	1.9	0	0.0	2	50.0
Irrigation :	0	0.0	0	*****	0	*****
Other :	0	0.0	0	*****	0	*****

is the number of wells or detections in that category.
% is the percentage of wells or detections in that category.

More detailed relationships between well characteristics and nitrate are generally easier to define because of the much higher percentage of nitrate detections. The relationship between the intervals of nitrate concentrations and various well characteristics is shown graphically in Figures 7 through 10. The number of wells sampled in each category is shown at the top of the columns in the graphs.

Figure 7 depicts the percentage of nitrate detections versus well depth for various detection concentration intervals. The highest overall percentage of nitrate detections occurred in wells less than 20 feet deep. In general, the percentage of intermediate- and high-concentration detections decreased with increasing well depth, while the low-concentration detections were about the same, regardless of well depth.

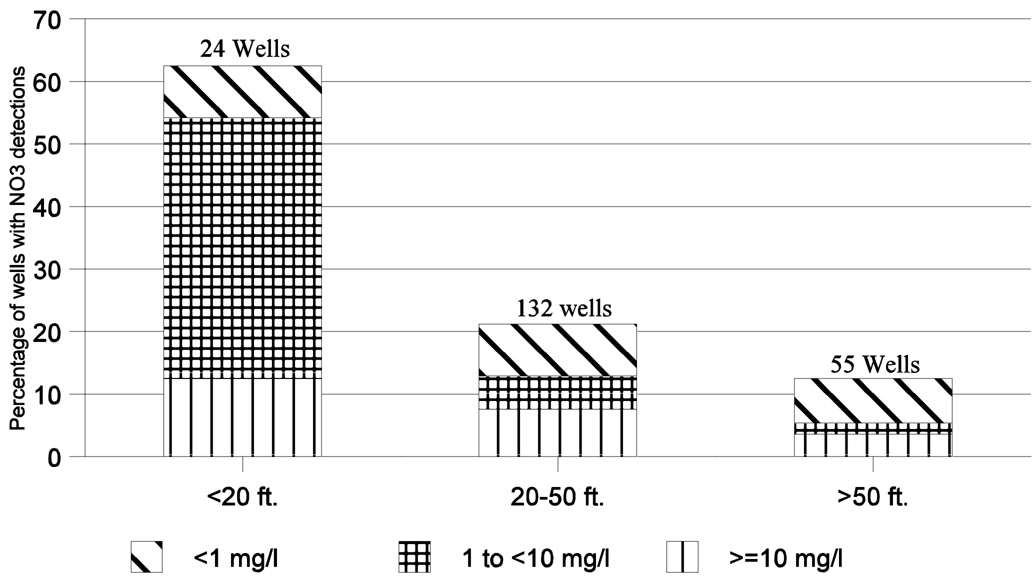

Figure 7. Graph of nitrate detections vs. well depth

Figure 8 depicts the percentage of nitrate detections versus the depth to the top of the screened interval. As with well depth, the greatest percentage of nitrate detections occurred in wells in which the top of the screened interval was less than 20 feet below ground surface. The overall percentage of nitrate detections decreased with increasing depth to the top of the screened interval, as did the percentages of the high-, intermediate- and low-concentration detections, except for wells in which the depth to the top of the screened interval was greater than 50 feet. In these wells, the low-concentration detections increased over the 20- to 50-feet interval.

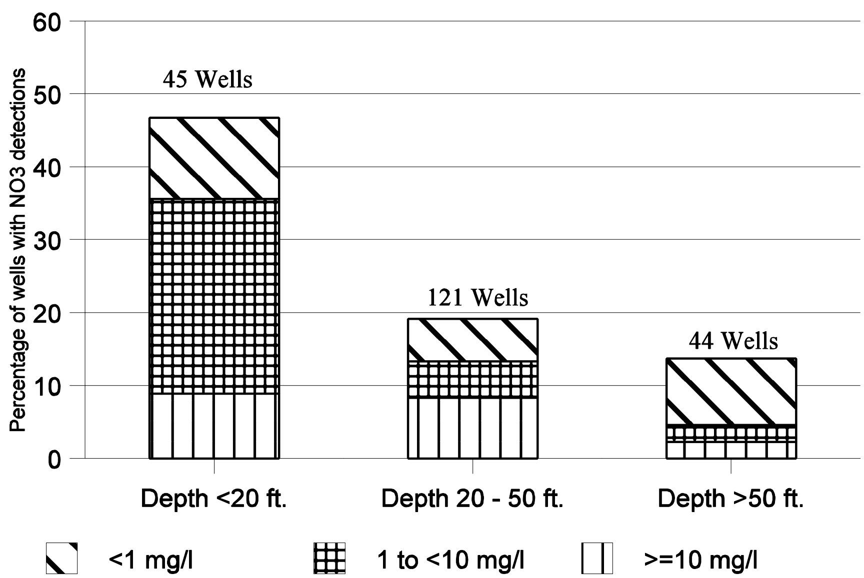

FIGURE 8. Graph of nitrate detections vs. depth to top of screened interval

As shown in Figure 9, almost 70 percent of wells in which the distance from the water table to the top of the screen was less than 10 feet contained nitrate. Although the overall percentage of nitrate detections decreased with increasing distance from the water table to the top of the screen, the percentages of nitrate concentrations in the two other distance intervals, 10 to 30 feet and greater than 30 feet, were both less than 10 percent. This relationship did not follow through for the various concentration intervals, however. There were no intermediate nitrate concentrations detected in wells in which the distance from the water table to the top of the screen was 30 to 50 feet, and no low concentration detections in the greater than 30-feet depth interval.

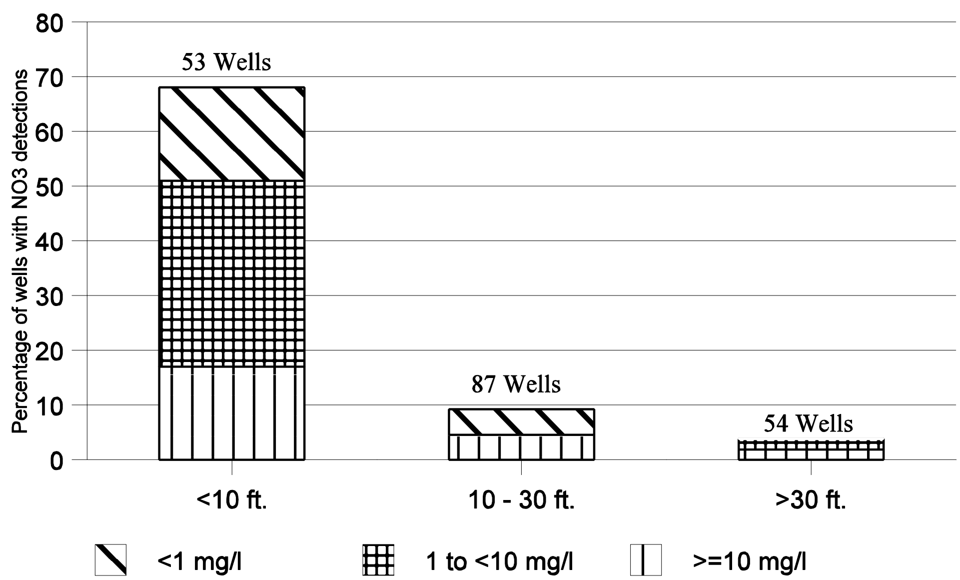

FIGURE 9. Graph of nitrate detections vs. distance from water table to the top of the screen

Figure 10 depicts the percentage of nitrate detections versus well type for various concentration intervals. Livestock, irrigation and public supply wells are not depicted on the graph because very few of these wells were sampled. The overwhelming majority of wells sampled were monitoring wells, which had the highest overall percentage of nitrate detections. The percentages of high, intermediate and low nitrate concentrations were almost identical – about 7 percent -- in both monitoring and private/domestic wells. The only exception was the intermediate-concentration interval in monitoring wells, which was approximately 10 percent.

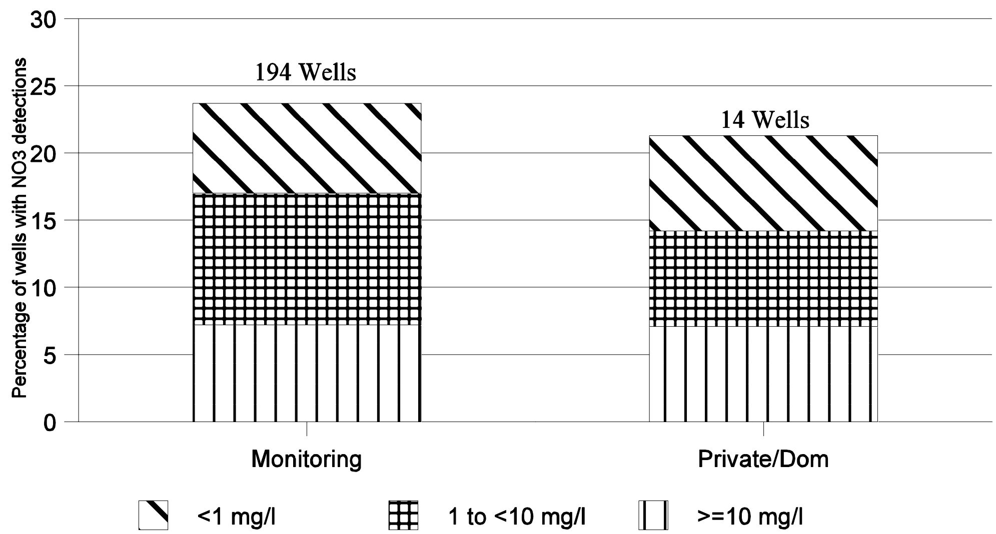

Figure 10. Graph of nitrate detections vs. type of well

Low-concentration detections of nitrate generally correspond less closely to the various well construction factors than higher concentrations. Higher concentration detections are more likely to result from point sources of pollution, rather than non-point sources, which may explain the relationship between high nitrate concentration detections and well construction. Detections resulting from non-point sources may likely occur regardless of well construction characteristics because of the widespread nature of non-point nitrate contamination. This study, however, did not identify whether any individual detection is caused by point or non-point sources.

Site-Inventory Data / Water Quality Relationships

Based upon the information collected as part of this survey, it is also difficult to relate pesticide detections to site characteristics or land use. The total number of pesticide detections is too low to arrive at relationships with any degree of confidence. It also was attempted to relate the distance from the well of certain site characteristics to pesticide and nitrate detections. This was also largely inconclusive for pesticide detections because of the small number of detections related to each site characteristic. Refer to Table 10 for a summary of statistics on pesticide and nitrate detections related to site-inventory characteristics. Appendix D contains these summary statistics for each aquifer.

TABLE 10
Pesticide and Nitrate Plus Nitrite Detections Related to Site-Inventory Data
For All Aquifers Sampled in 1998

NUMBER OF DETECTIONS		#	PERCENT
Wells with only pesticide detections	:	15	7.0 %
Wells with only nitrate detections	:	47	22.0 %
Wells with pesticide & nitrate detections	:	4	1.9 %
Wells with nitrate > 10 mg/L	:	15	7.0 %

Total number of wells in sample population : 214

AQUIFER	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
DENBIGH :	6	2.8	0	0.0	0	0.0
ELK VALLEY :	83	38.8	8	9.6	17	20.5
FORDVILLE :	10	4.7	1	10.0	3	30.0
INKSTER :	8	3.7	0	0.0	2	25.0
KARLSRUHE :	19	8.9	2	10.5	10	52.6
LAKE SOURIS :	33	15.4	3	9.1	7	21.2
MCVILLE :	9	4.2	0	0.0	3	33.3
NEW ROCKFORD :	13	6.1	3	23.1	3	23.1
SHELL VALLEY :	19	8.9	0	0.0	4	21.1
STRAWBERRY LAKE :	9	4.2	2	22.2	1	11.1
TURTLE LAKE :	5	2.3	0	0.0	1	20.0

GENERAL SETTING	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
Farm Yard :	20	9.3	3	15.0	4	20.0
Field :	130	60.7	10	7.7	33	25.4
Pasture :	45	21.0	5	11.1	8	17.8
C.R.P. :	22	10.3	3	13.6	8	36.4
Roadside :	124	57.9	11	8.9	32	25.8
Town :	3	1.4	0	0.0	0	0.0

NEARBY FACTORS OF POSSIBLE INFLUENCE	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
Near Irrigation :	56	26.2	8	14.3	20	35.7
Near Feed Lot :	7	3.3	1	14.3	3	42.9
Near Disposal Area :	0	0.0	0	*****	0	*****
Near Septic System :	24	11.2	3	12.5	9	37.5
Near Surface Water :	50	23.4	8	16.0	7	14.0
Well in Depression :	2	0.9	0	0.0	0	0.0
Near Chemical Use :	17	7.9	2	11.8	7	41.2
Other :	12	5.6	3	25.0	3	25.0

NEAR IRRIGATION	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
0 - 100 ft. :	15	7.0	3	20.0	9	60.0
100 ft. - 1/8 mile :	41	19.2	5	12.2	11	26.8

NEAR A FEED LOT	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
0 - 100 ft. :	3	1.4	0	0.0	1	33.3
100 ft. - 1/8 mile :	4	1.9	1	25.0	2	50.0

NEAR DISPOSAL AREA	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
0 - 100 ft. :	0	0.0	0	*****	0	*****
100 ft. - 1/8 mile :	0	0.0	0	*****	0	*****

NEAR SEPTIC SYSTEM	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
0 - 100 ft. :	4	1.9	0	0.0	0	0.0
100 ft. - 1/8 mile :	20	9.3	3	15.0	9	45.0

NEAR SURFACE WATER	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
0 - 100 ft. :	16	7.5	3	18.8	2	12.5
100 ft. - 1/8 mile :	34	15.9	5	14.7	5	14.7

DEPRESSION AROUND WELL	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
Yes :	2	0.9	0	0.0	0	0.0
No :	211	98.6	18	8.5	51	24.1
Unknown :	0	0.0	0	*****	0	*****

NEAR CHEMICAL USAGE, MIXING, OR STORAGE	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
Pesticides :	1	0.5	0	0.0	0	0.0
Fertilizer :	0	0.0	0	*****	0	*****
Petroleum :	16	7.5	2	12.5	7	43.8
Other :	1	0.5	1	100.0	1	100.0

NEAR PESTICIDE USAGE, MIXING, OR STORAGE	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
0 - 100 ft. :	0	0.0	0	*****	0	*****
100 ft. - 1/8 mile :	1	0.5	0	0.0	0	0.0

NEAR FERTILIZER USAGE, MIXING, OR STORAGE	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
0 - 100 ft. :	0	0.0	0	*****	0	*****
100 ft. - 1/8 mile :	0	0.0	0	*****	0	*****

NEAR PETROLEUM STORAGE	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
0 - 100 ft. :	4	1.9	0	0.0	4	100.0
100 ft. - 1/8 mile :	12	5.6	2	16.7	3	25.0

CROPS CLOSE TO WELL	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
Small Grains :	105	49.1	7	6.7	21	19.8
Row Crops :	122	57.0	11	9.0	39	32.0
Hay :	68	31.8	6	8.8	14	20.6
Pasture :	75	35.0	8	10.7	13	17.3
C.R.P. :	54	25.2	6	11.1	15	27.8

NEAR SMALL GRAIN CROPS	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
0 - 100 ft. :	92	43.0	6	6.5	20	21.5
100 ft. - 1/8 mile :	13	6.1	1	7.7	1	7.7

NEAR ROW CROPS	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
0 - 100 ft. :	86	40.2	8	9.3	27	31.4
100 ft. - 1/8 mile :	36	16.8	3	8.3	12	33.3

NEAR HAY CROPS	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
0 - 100 ft. :	58	27.1	5	8.6	13	22.4
100 ft. - 1/8 mile :	10	4.7	1	10.0	1	10.0

NEAR PASTURE	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
0 - 100 ft. :	62	29.0	6	9.7	12	19.4
100 ft. - 1/8 mile :	13	6.1	2	15.4	1	7.7

NEAR C.R.P.	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
0 - 100 ft. :	43	20.1	3	7.0	12	27.9
100 ft. - 1/8 mile :	11	5.1	3	27.3	3	27.3

is the number of wells or detections in that category.
% is the percentage of wells or detections in that category.

Because of the greater number of nitrate detections compared to pesticide detections, however, it was possible to relate nitrate detections to site-inventory data, as depicted in Figures 11 through 13. Figure 11 depicts the percentage of nitrate plus nitrite detections versus general setting at various nitrate concentrations. The general setting of a well located near CRP land had the greatest percentage of nitrate detections at 36 percent. CRP land also had the highest percentages of wells with nitrate detections greater than the MCL of 10 mg/l (N), at slightly over 18 percent. Often the sites had characteristics of more than one type of general setting; for example, a well located on the boundary of a farmyard and a pasture, adjacent to a road ditch. In 1995, an additional general setting data field was added to the inventory form and to the database to help account for wells with characteristics of more than one setting.

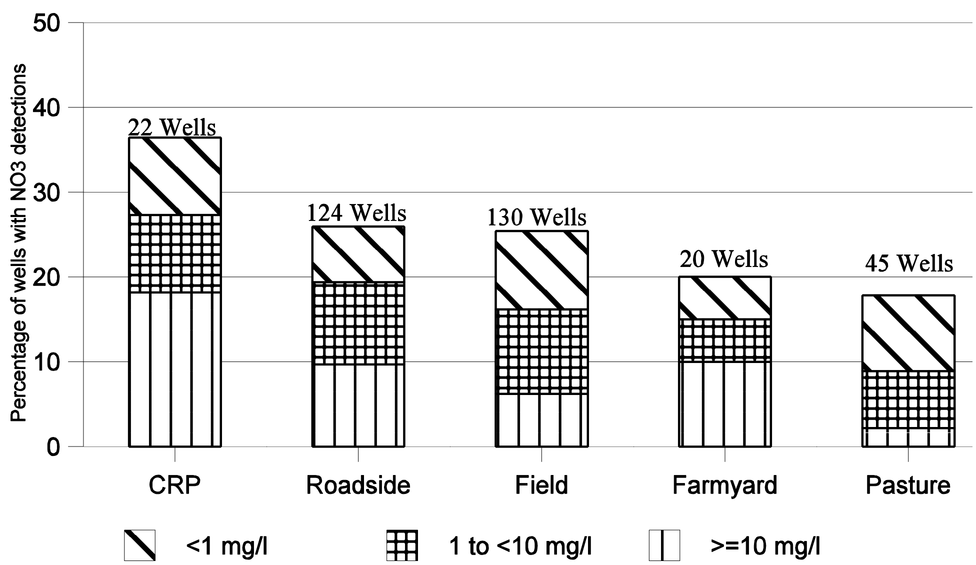

FIGURE 11. Graph of nitrate detections vs. general setting

An attempt was made to relate various factors of land use and their distance from the well to greater percentages of pesticide and nitrate detections. The only factor for which a shorter distance from the well seemed to correspond to greater percentages of both pesticide and nitrate detections was proximity to irrigation. A greater percentage of pesticide detections seemed to correspond to shorter distance to surface water; however, of the various factors considered, wells near surface water had the smallest percentage of nitrate detections.

As depicted in Figure 12, close proximity to feedlots was associated with the greatest overall percentage of nitrate detections at 43 percent and with the greatest percentage of wells exceeding the 10 mg/l (N) nitrate MCL at 29 percent. Although only seven wells near feedlots were reportedly sampled, previous monitoring has shown a relationship between feedlots and nitrate detections, particularly higher concentration detections. Wells in close proximity to feedlots also had the greatest percentage of nitrate concentrations less than 1.0 mg/l; however, there were no intermediate concentration detections in these wells. Wells near feedlots were followed closely by those near chemical usage (41 percent), septic systems (38 percent) and irrigation (36 percent). Of the 17 wells reportedly near chemical usage, the chemicals involved in 16 wells were petroleum products in aboveground storage tanks rather than pesticides or fertilizers. Landowners around monitoring wells generally were not interviewed; therefore, numbers relating to verified chemical or fertilizer usage, mixing and storage are greatly understated. In addition, landowners who were interviewed rarely indicated chemical or fertilizer usage, mixing or storage in areas surrounding privately owned domestic, stock or irrigation wells, although it could be assumed that these activities probably have occurred more often than was reported.

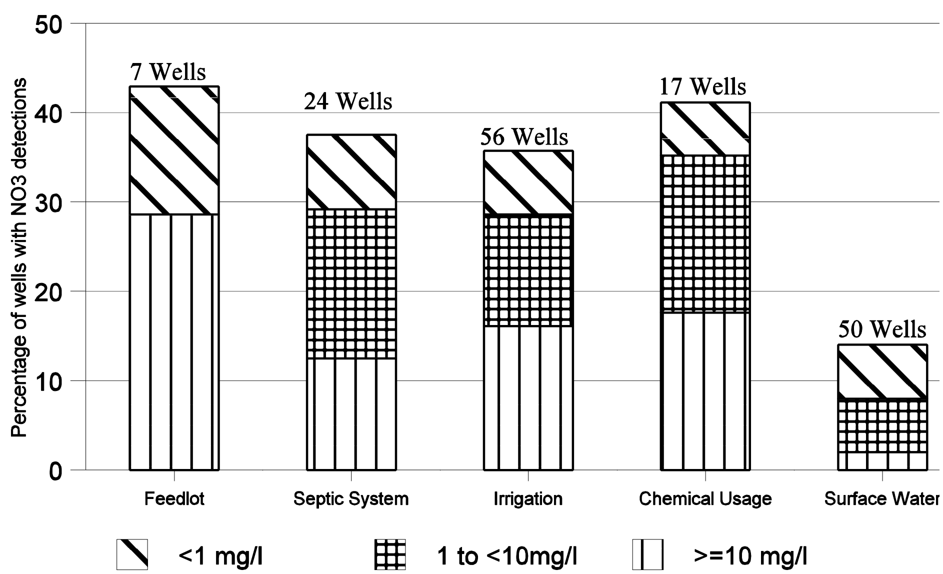

FIGURE 12. Graph of nitrate detections vs. other factors of possible influence within one-eighth mile of the well

As depicted in Figure 13, wells near row crops had the highest percentage of nitrate detections for the various crop types, at 32 percent. Wells near row crops also had the greatest percentages of high- and intermediate-concentration detections. Wells near row crops were followed closely by those near CRP acreage. Distances from row crops to the well did seem to relate to greater percentages of pesticide detections (Table 10). However, this relationship did not follow through for nitrate detections, although the percentages of nitrate detections for the 0 to100 feet and 100 feet to one-eighth mile categories were very close. In fact, distances from crop types to the well seemed to relate to greater percentages of nitrate detections for all crop types *except* row crops.

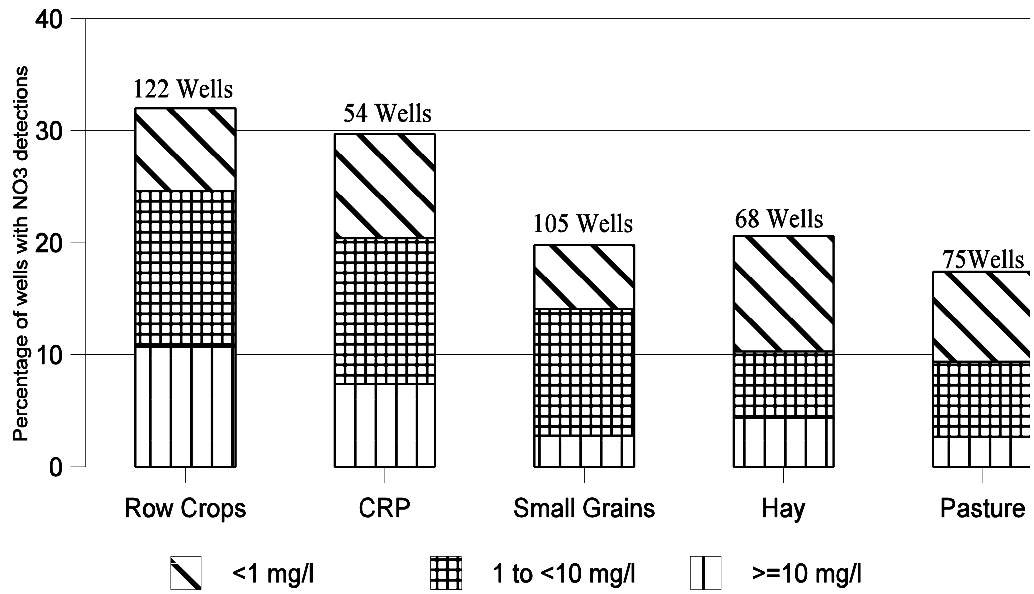

FIGURE 13. Graph of nitrate detections vs. crop type

It must be stated that the relationship of two variables, in this case the occurrence of greater percentages of nitrate detections related to various well-construction or site inventory-factors, does not necessarily imply a cause-and-effect relationship. None of the well-construction and site-inventory factors are necessarily independent, and some may have a cumulative effect on water quality. Within this study there is not enough specific data to determine all of the interrelationships of the factors. There are also factors that are inadequately accounted for, or not accounted for at all, such as chemical usage and precipitation. A higher percentage of nitrate detections for any one factor only indicates that there is a somewhat higher possibility of that factor having an influence on water quality in this sample population. It should be noted that statistical analysis and comparison of the various factors performed on the sample set as a whole and on each of several subset populations for the first five-year monitoring cycle, 1992-1996, determined that many of the nitrate detection relationships remain when looking at larger groups of wells.

SUMMARY AND CONCLUSIONS

Two hundred fourteen wells from 11 glacial drift aquifers were sampled for general anion and cation chemistry, nitrate plus nitrite, and 60 selected pesticides and pesticide degradation products. Nineteen wells, or approximately 9 percent of the wells sampled, contained detectable concentrations of pesticides in at least one of the sampling periods. The Elk Valley aquifer had eight wells with pesticide detections, the Lake Souris and New Rockford aquifers each had three wells with pesticide detections, the Karlsruhe and Strawberry Lake aquifers each had two wells with pesticide detections and the Fordville aquifer had one well with a pesticide detection. Seven pesticide species were positively identified by laboratory analysis: bentazon, 2,4-D, endrin, 3-hydroxycarbofuran, methomyl, picloram and triallate.

Most concentrations of the detected pesticides were far below their respective MCLs or HALs. The highest concentration of a detected pesticide was of bentazon at 14 μg/l, or 70 percent of the HAL. Picloram was the pesticide found most frequently and the only one confirmed in either duplicate or follow-up samples. All concentrations of picloram were less than 1 percent of the MCL. Other pesticide concentrations detected ranged from 0.357 to 1.18 percent of their respective MCL or HAL. Several pesticide detections, of picloram in particular, appear to be associated with a point source of contamination, most likely the spraying of road ditches for leafy spurge control.

Nitrate was found above the 0.05 mg/l (N) minimum detection limit in 51 wells, or approximately 24 percent of the wells sampled. The concentration of nitrate was above the 10 mg/l (N) MCL in 15 wells, or 7 percent of the total wells sampled. Of the wells with nitrate detections, almost 40 percent had concentrations between 0.05 and 1.0 mg/l (N). Several nitrate detections seem to be associated with nonpoint source activities or could not be identified as either point or nonpoint source. Shallow depth of the well; shallow depth to the top of the screened interval; shorter distance from the water table to the top of the screen; and proximity to irrigation, feedlots, row crops and CRP are the factors associated with the highest percentages of nitrate detections.

Comparing the 1998 monitoring results to those of previous years, the percentage of wells with pesticide detections is approximately four times those of 1992 and 1995 and twice those of 1996 and 1997, but about one-half the percentages encountered in 1993 and 1994, when flooding and heavy precipitation had an apparent effect on groundwater quality. Although these conditions also preceded the 1997 sampling season, the percentage of pesticide detections that year was only 4 percent; however, the heavy precipitation came mainly in the form of snow, and the flooding occurred in early spring while the ground was still frozen and prior to chemical application. In 1998, the percentage of wells with nitrate detections was the lowest recorded since the beginning of the monitoring program, at slightly under 24 percent. The percentage of wells with nitrate concentrations at or above the 10 mg/l (N) MCL has remained at 7 percent for the past three years. Different aquifers were monitored each year of the study from 1992 to 1996. In 1997 and 1998, resampling was conducted of those aquifers initially sampled in 1992 and 1993; however, new aquifers also were added to the monitoring schedule. Therefore, these percentages do not attempt to draw a direct comparison from one year to another, but rather, illustrate the variability in detections from year to year, which may be due to different aquifers monitored, varying climatic conditions, or any number of factors.

In 1998, the Elk Valley, Fordville, Inkster, Denbigh, Lake Souris and Shell Valley aquifers underwent their first five-year resampling since 1993. An attempt was made to resample the same wells; however, this was not always possible. In some cases the well was no longer in existence or had been damaged so that the integrity of the well was in question, several of the wells originally sampled could not be reached because of wet conditions, and, in some instances, attempts to contact landowners for permission to sample a well were unsuccessful. In 1993, 117 wells were sampled in the six above-mentioned aquifers. Twenty-one wells, just under 18 percent, contained detectable concentrations of pesticides. Fourteen of the original 21 wells with pesticide detections were resampled in 1998; pesticides were detected in the resample from three of the wells. All three wells are in the Elk Valley aquifer and have been sampled on at least three occasions – in 1993, 1994 and 1998; two of the wells also were sampled in 1999. The wells contained a detectable concentration of a pesticide in each sampling event. In all cases, the pesticide detected was picloram.

When comparing only those aquifers and wells sampled in both years, 1993 and1998, there do not appear to be any significant changes over the course of the five-year period. Both the number and percentage of wells with pesticide detections either decreased or remained the same in five of the six aquifers, except the Lake Souris aquifer, in which both increased. In general, the overall percentage of nitrate detections decreased in the Elk Valley aquifer, both when comparing all wells sampled in 1993 and 1998 and when comparing only the same wells sampled in both years. Overall, the percentage of nitrate concentrations in the Lake Souris and Shell Valley aquifers decreased from 1993 to 1998. When comparing the same wells sampled in both years in the two aquifers, the percentages of nitrate concentrations in the wells showed an increase. However, in both cases, the increases were attributable to the detection of nitrate in only one additional well. In the Inkster aquifer, the overall percentage of nitrate detections appeared to increase markedly from 1993 to 1998 – from approximately 11 percent to 25 percent. This was also due to a change in only one well: in 1993, one well had a nitrate detection in the aquifer; in 1998, two wells had nitrate detections. When comparing only those wells sampled in both years, the percentage of nitrate detections was unchanged. In the Denbigh aquifer, only one well was sampled both years; no nitrates or pesticides were detected in the well either year. None of the wells sampled in the Fordville aquifer in 1993 were able to be resampled in 1998.

Based upon the data collected, pesticide contamination of groundwater in the aquifers sampled in 1998 is minor in extent and severity. Resampling of wells shows that the occurrence of pesticides in this study, even in the same well, is highly variable and often of short duration. Nitrate contamination in these aquifers appears to be similar to that encountered in aquifers monitored previously; however, nitrate concentrations in specific individual wells have the potential to cause adverse health impacts to those well users.

Because of the apparent relationship between contaminant detections and several well-construction and/or site-activity factors, it is recommended that nonpoint and especially point source activities should be conducted carefully to prevent future contamination. Placement of drinking water wells should avoid areas of potential point sources of contamination, and they should be constructed to prevent direct contamination of the well from surface activities.

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APPENDIX A

Site Inventory Form

AMBIENT GROUNDWATER MONITORING
SITE INVENTORY

Site ID/Sample #____________________ Project Code_______ Sample Type(s): **Reg. Dup. Blank**
Date___________ Time________ D/B Time_______ Collector(s)_____________________________
Analyses: **Pesticides Carbamates Metals Gen. Chem**
Nitrates All of the Above Other____________________________________
Weather Conditions____
Latitude/Longitude Field Reading____
Comments:

OWNER INFORMATION

Owner____ Renter: **Yes No**
c/o____
Address____ Phone# (____)______-____________
City____ State_________ Zip Code___________
Contact Person__________________________________ Rel. To owner____________________
Comments:

WELL INFORMATION

Well name or # other than ID____
Casing diameter________________________ Completed well depth________________________
Casing material: **PVC Stainless Steel Iron Wood Masonry Other**________________
Pump type: **Bailer Submersible Jet Hand/Windmill Bladder Other**________________
Ground elevation______________________ Date constructed______________________________
Top open interval______________________ Bottom open interval__________________________
Water use: **Domestic Public Stock Observation Irrigation Industrial Other**_____________
Well construction: **Rotary Bored/Auger Dug Sand Point Cable Other**___________________
Well is used: **Daily Seasonally Backup Observation Other**______________________
Protective cap: **Yes No Unknown** Properly sealed: **Yes No Unknown**
Sampling point________________________ Aquifer_______________________________________
County_______________________________ Driller_______________________________________
Comments:

SITE DATA

Depression aound casing: **Yes No Unknown**
Near irrigation: **Yes No Unknown** Distance: **0-100' 100'-1/8 mile**
Recent precipitation: **Yes No Unknown** Amount_________________________________
Topography: **Flat Sloping Rolling Hilly Other**______________________________
Comments:

CHEMICAL USAGE NEAR WELL

Pesticides **Fertilizer** **Petroleum - UST, AST** **Other**___________________________
Chemical name__________________________ Date put in area______________________________
Store__________ **Mix**___________ **Load**_________ **Apply**_________ **Dispose**___________
Gradient from well: **Up** **Down** **Both** **Even** Distance from well: **0-100'** **100'-1/8 mile**

Pesticides **Fertilizer** **Petroleum - UST, AST** **Other**___________________________
Chemical name__________________________ Date put in area______________________________

Store__________ **Mix**___________ **Load**_________ **Apply**_________ **Dispose**___________
Gradient from well: **Up** **Down** **Both** **Even** Distance from well: **0-100'** **100'-1/8 mile**

Pesticides **Fertilizer** **Petroleum - UST, AST** **Other**________________
Chemical name_________________________ Date put in area________________________
Store__________ **Mix**___________ **Load**_________ **Apply**_________ **Dispose**___________
Gradient from well: **Up** **Down** **Both** **Even** Distance from well: **0-100'** **100'-1/8 mile**
Comments:

Have there been any nearby chemical spills? **Yes** **No** **Unknown**
Gradient from well: **Up** **Down** **Both** **Even** Distance from well: **0-100'** **100'-1/8 mile**
Recent change in water quality? **Yes** **No** **Unknown** When? ______________________
Taste **Odor** **Color** **Appearance** **Other**___________________________
Previous chemical/bacteriological analyses? **Yes** **No** **Unknown**
Results:____
Comments:

CROPS NEAR WELL

Small Grains **Row Crops** **Oil Seeds** **Hay** **Pasture** **CRP**
Gradient from well: **Up** **Down** **Both** **Even** Distance from well: **0-100'** **100'-1/8 mile**

Small Grains **Row Crops** **Oil Seeds** **Hay** **Pasture** **CRP**
Gradient from well: **Up** **Down** **Both** **Even** Distance from well: **0-100'** **100'-1/8 mile**

Small Grains **Row Crops** **Oil Seeds** **Hay** **Pasture** **CRP**
Gradient from well: **Up** **Down** **Both** **Even** Distance from well: **0-100'** **100'-1/8 mile**

Small Grains **Row Crops** **Oil Seeds** **Hay** **Pasture** **CRP**
Gradient from well: **Up** **Down** **Both** **Even** Distance from well: **0-100'** **100'-1/8 mile**

Comments:

NEARBY FACTORS OF POSSIBLE INFLUENCE

Feedlots **Disposal area** **Septic system** **Surface water** **Other**__________________
Gradient from well: **Up** **Down** **Both** **Even** Distance from well: **0-100'** **100'-1/8 mile**

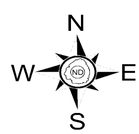
Feedlots **Disposal area** **Septic system** **Surface water** **Other**__________________
Gradient from well: **Up** **Down** **Both** **Even** Distance from well: **0-100'** **100'-1/8 mile**

Feedlots **Disposal area** **Septic system** **Surface water** **Other**__________________
Gradient from well: **Up** **Down** **Both** **Even** Distance from well: **0-100'** **100'-1/8 mile**

Feedlots **Disposal area** **Septic system** **Surface water** **Other**__________________
Gradient from well: **Up** **Down** **Both** **Even** Distance from well: **0-100'** **100'-1/8 mile**

Feedlots **Disposal area** **Septic system** **Surface water** **Other**__________________
Gradient from well: **Up** **Down** **Both** **Even** Distance from well: **0-100'** **100'-1/8 mile**

Comments:



Comments:

Draw a general map of the area - section / ¼ section / farmsite / etc. Locate wells, buildings, crops, and other operations that may impact water quality.

WELL STABILIZATION DATA

Site ID/Sample #______________________________________ Date_________________________

Type of pump______________________________ Pumping rate____________________________

Regular sample time___________________________ Duplicate/Blank sample time______________

Time	Temperature	pH	Temperature-corrected Conductivity (μmhos/cm)	Volume of Water Removed From Well (Cumulative)

Well depth from top of casing*
-Casing length from top to ground
= Well depth

Water level from top of casing
-Casing length from top to ground
= Depth to water

Well depth ______________
-Depth to water ______________
=Lineal feet ______________ X ________ = ___________ (Volume of water in casing)

(*Measurements to nearest 0.01 ft. before pumping or bailing)

Calculate one well volume using the table below:

Well diameter in inches:	¾	1	1 ¼	1 ½	2	3	4	6
Gallons per lineal foot of water in well:	0.023	0.04	0.06	0.09	0.16	0.37	0.67	1.47
Liters per lineal foot of water in well:	0.087	0.15	0.24	0.34	0.60	1.4	2.53	5.56

(Gallons x 3.7853 = liters

Liters x.2642 = gallons)

WELL SETTING

Primary setting:	**Farmyard**	**Field**	**Pasture**	**CRP**	**Roadside**	**Town**
Secondary setting:	**Farmyard**	**Field**	**Pasture**	**CRP**	**Roadside**	**Town**

Color______________________________ Appearance_____________________________

Odor_______________________________ Taste__________________________________

Comments:

APPENDIX B

General Inorganic Water Quality Analyses

*** Denbigh Aquifer ***

WELL ID (TRSQ)	Na	Mg	SiO2	K	Ca	Mn	Fe	Cl	F	pH	CO3	HCO3	OH	Alk.	Cond.	SO4	NO3	CaCO3	Hard.	Turb.	% Na	SAR	TDS
15507604BBB	41.2	31.3	34.1	5.4	90.5	0.793	4.80	5.16		7.14	< 1	495.	< 1	405.	715.	27.9	< 0.05	355.	21.	11.9	19.8	0.95	447.
15507610CCC	10.0	18.8	48.8	4.7	76.8	0.509	14.8	< 0.3		7.33	< 1	349.	< 1	286.	484.	< 0.3	< 0.05	269.	16.	76.0	7.3	0.26	285.
15507704CBC	6.1	24.5	70.1	1.8	72.1	2.02	42.0	1.64		6.74	< 1	339.	< 1	278.	497.	20.8	< 0.05	281.	16.	499.	4.5	0.16	296.
15607713CCB2	2.6	14.3	37.3	2.3	75.4	0.233	9.41	2.29		7.94	< 1	333.	< 1	273.	491.	15.5	< 0.05	247.	14.	50.0	2.2	0.07	279.
15607724CCC	17.5	18.7	27.3	1.7	69.6	0.199	6.41	8.66		7.32	< 1	358.	< 1	293.	571.	12.9	< 0.05	251.	15.	58.0	13.0	0.48	308.
15607729BBC	15.4	22.9	28.3	3.0	88.0	0.110	7.21	1.14		7.31	< 1	450.	< 1	369.	684.	16.0	< 0.05	314.	18.	66.0	9.5	0.38	370.
MINIMUM	2.6	14.3	27.3	1.7	69.6	0.110	4.80	< 0.3		6.74	< 1	333.	< 1	273.	484.	< 0.3	< 0.05	247.	14.	11.9	2.2	0.07	279.
MAXIMUM	41.2	31.3	70.1	5.4	90.5	2.02	42.0	8.66		7.94	< 1	495.	< 1	405.	715.	27.9	< 0.05	355.	21.	499.	19.8	0.95	447.
MEAN	15.5	21.8	41.0	3.2	78.7	0.644	14.11	3.2	.	7.30	0.5	387	0.5	317	573.7	16	0.01	286	17	127	9.4	0.4	331
MEDIAN	12.7	20.9	35.7	2.7	76.1	0.371	8.31	2.0	.	7.32	0.5	354	0.5	290	534.0	16	0.01	275	16	62	8.4	0.3	302
STDDEV	13.8	5.9	16.2	1.6	8.6	0.719	14.10	3.2	.	0.39	0.0	68	0.0	56	102.9	9	0.00	41	3	184	6.3	0.3	66

*** Elk Valley Aquifer ***

WELL ID (TRSQ)	Na	Mg	SiO2	K	Ca	Mn	Fe	Cl	F	pH	CO3	HCO3	OH	Alk.	Cond.	SO4	NO3	CaCO3	Hard.	Turb.	% Na	SAR	TDS
14905403AAA	26.9	124.	70.9	10.2	535.	5.62	50.8	2.88	0.12	6.99	< 1	254.	< 1	208.	2660	1610	< 0.05	1850	108.	174.	3.0	0.27	2440
14905404BBB	< 0.1	19.5	33.4	3.3	61.6	0.866	6.84	0.51		7.48	< 1	257.	< 1	210.	414.	18.0	< 0.05	234.	14.	29.0	0.1	0.00	232.
15005401AAA	7.1	23.6	44.3	4.3	121.	1.63	18.5	1.74		7.26	< 1	505.	< 1	414.	720.	17.7	< 0.05	400.	23.	69.0	3.7	0.15	426.
15005403CDD2	0.2	23.7	27.5	1.4	126.	0.991	2.49	1.14		7.30	< 1	454.	< 1	372.	711.	54.9	< 0.05	413.	24.	66.0	0.1	0.00	433.
15005404BBB	17.1	24.4	32.8	6.6	107.	0.518	2.94	1.14		7.27	< 1	373.	< 1	305.	708.	90.6	< 0.05	368.	21.	19.0	9.0	0.39	433.
15005405BBA2	107.	230.	38.0	5.5	208.	1.38	17.0	1.70	1.01	7.61	< 1	322.	< 1	264.	2400	1290	4.50	1470	86.	220.	13.6	1.21	2020
15005406CCC	14.8	48.7	35.0	8.0	186.	1.80	6.38	14.1		7.08	< 1	713.	< 1	584.	1160	99.9	< 0.05	665.	39.	74.0	4.5	0.25	725.
15005406CCC	17.6	65.8	54.3	9.9	230.	2.57	16.7	84.0		7.06	< 1	747.	< 1	612.	1380	79.1	< 0.05	846.	49.	370.	4.2	0.26	856.
15005410CCC	6.2	18.4	30.6	3.9	83.2	0.481	0.669	1.01		7.45	< 1	363.	< 1	297.	535.	35.1	< 0.05	284.	17.	10.0	4.4	0.16	329.
15005411CCC	60.5	166.	28.5	10.8	303.	1.30	4.08	1.87	0.12	7.15	< 1	397.	< 1	325.	2540	1260	< 0.05	1440	84.	28.5	8.3	0.69	2000
15005412CCC	< 0.1	26.9	29.6	2.3	74.2	0.625	0.706	0.97		7.43	< 1	351.	< 1	287.	585.	28.0	< 0.05	296.	17.	7.00	0.1	0.00	307.
15005416CBC2	1.8	31.9	48.0	< 1	78.8	1.44	22.3	9.33		7.60	< 1	296.	< 1	242.	597.	48.7	12.8	328.	19.	270.	1.2	0.04	376.
15005419BBB	30.4	82.9	32.4	8.3	314.	2.49	0.186	53.8		7.12	< 1	354.	< 1	290.	1890	814.	< 0.05	1130	66.	2.50	5.5	0.39	1480
15005420AAA	85.8	97.7	31.9	11.6	345.	2.12	5.08	1.70	0.20	7.11	< 1	376.	< 1	308.	2250	1150	< 0.05	1260	74.	19.0	12.7	1.05	1880
15005422DDD	47.7	75.8	30.9	11.6	338.	2.12	1.31	3.77		7.07	< 1	348.	< 1	285.	1930	931.	< 0.05	1160	68.	18.0	8.1	0.61	1580
15005424CCD	11.9	77.5	29.9	6.5	273.	1.28	1.88	1.84		7.15	< 1	331.	< 1	271.	1740	752.	< 0.05	1000	58.	12.0	2.5	0.16	1290
15005429AAAD2	3.6	44.0	34.3	1.5	99.9	0.404	3.57	15.6		7.57	< 1	410.	< 1	336.	763.	52.5	9.38	431.	25.	150.	1.8	0.08	463.
15005513AAA	39.2	65.8	39.8	9.2	215.	1.96	6.18	15.4		7.15	< 1	392.	< 1	321.	1460	517.	< 0.05	808.	47.	40.0	9.4	0.60	1060
15005525AAA	25.3	56.2	32.9	6.3	214.	1.61	1.59	15.5		7.18	< 1	387.	< 1	317.	1340	440.	< 0.05	766.	45.	22.0	6.6	0.40	950.
15005525AAA	30.7	62.4	30.2	7.1	219.	1.82	2.89	15.7		6.92	< 1	382.	< 1	313.	1470	546.	< 0.05	804.	47.	53.2	7.6	0.47	1070
15105407BBB2	11.3	27.9	30.6	5.7	140.	0.309	0.325	6.32		7.29	< 1	420.	< 1	344.	963.	83.3	< 0.05	465.	27.	2.50	4.9	0.23	484.
15105415CDD	7.1	35.4	34.2	5.0	81.2	0.834	4.81	6.63		7.50	< 1	339.	< 1	278.	684.	90.9	< 0.05	349.	20.	31.0	4.1	0.17	395.
15105419CCC	3.6	33.8	34.5	5.8	166.	1.73	2.89	11.0		7.14	< 1	601.	< 1	492.	991.	55.0	< 0.05	554.	32.	23.0	1.4	0.07	573.
15105419CCC	6.7	34.8	28.2	6.3	168.	1.67	1.55	12.1		7.24	< 1	633.	< 1	518.	986.	59.8	< 0.05	563.	33.	17.7	2.5	0.12	602.
15105419DDD	< 0.1	20.5	36.6	3.5	96.9	1.08	5.48	1.34		7.39	< 1	378.	< 1	310.	573.	25.2	< 0.05	327.	19.	39.0	0.1	0.00	336.
15105420BBB	12.8	22.0	30.7	5.9	128.	0.945	0.758	9.19		7.16	< 1	317.	< 1	260.	859.	206.	< 0.05	411.	24.	7.50	6.2	0.27	542.
15105421DDD	1.9	22.8	31.6	3.3	92.5	0.767	1.73	7.13		7.55	< 1	288.	< 1	236.	644.	105.	< 0.05	325.	19.	11.0	1.2	0.05	377.
15105423AAA	6.4	32.4	32.6	2.2	87.0	0.132	1.27	5.89		7.64	< 1	291.	< 1	238.	679.	111.	4.18	351.	20.	26.0	3.8	0.15	409.
15105425CCC	12.2	26.3	31.5	4.6	100.	0.501	1.08	0.74		7.32	< 1	411.	< 1	337.	735.	70.9	< 0.05	358.	21.	13.0	6.8	0.28	419.

All units reported in mg/l except: pH, Conductivity (umhos/cm), Hardness (gr/gal), Turbidity (NTU), % Na (%), and SAR (Sodium Adsorption ration).
CaCO3 is total hardness measured as calcium carbonate.

*** Elk Valley Aquifer *** (continued)

WELL ID (TRSQ)	Na	Mg	SiO2	K	Ca	Mn	Fe	Cl	F	pH	CO3	HCO3	OH	Alk.	Cond.	SO4	NO3	CaCO3	Hard.	Turb.	% Na	SAR	TDS
15105426BAB	5.7	21.0	33.3	3.7	94.8	0.902	1.53	0.98		7.32	< 1	352.	< 1	288.	630.	61.1	< 0.05	323.	19.	15.0	3.6	0.14	363.
15105428DCC2	< 0.1	33.7	37.4	1.9	102.	3.53	3.76	1.40		7.39	< 1	266.	< 1	218.	700.	151.	0.20	394.	23.	33.0	0.1	0.00	424.
15105429DDD	9.6	19.5	36.6	5.4	106.	1.20	3.30	1.62		7.29	< 1	367.	< 1	301.	667.	66.6	< 0.05	345.	20.	39.0	5.6	0.22	392.
15105431BBB	36.6	84.0	34.9	7.5	231.	1.91	3.98	9.52		7.06	< 1	488.	< 1	400.	1730	644.	< 0.05	923.	54.	26.0	7.8	0.52	1260
15105431BBB	37.1	97.5	30.1	8.3	258.	2.05	4.51	19.5		7.03	< 1	703.	< 1	576.	1790	546.	< 0.05	1050	61.	41.3	7.1	0.50	1310
15105433DCC	23.7	23.0	74.1	6.2	99.3	3.51	35.8	2.65		7.40	< 1	351.	< 1	287.	751.	116.	< 0.05	343.	20.	264.	12.8	0.56	446.
15105435DCC2	0.9	40.0	38.7	2.1	113.	2.22	6.98	6.62		7.35	< 1	380.	< 1	311.	724.	64.6	4.75	447.	26.	138.	0.4	0.02	438.
15105436CCC2	< 0.1	37.5	25.3	< 1	114.	0.269	0.143	8.90		7.48	< 1	493.	< 1	404.	825.	40.2	2.78	439.	26.	2.40	0.0	0.00	459.
15105501ADD	201.	< 0.1	29.8	1.3	0.1	< 0.002	0.046	51.1		7.36	< 1	331.	< 1	271.	955.	116.	< 0.05	1.	0.	< 1	99.5	106.	535.
15105501ADD	218.	0.2	25.9	< 1	0.2	< 0.002	0.065	49.9		7.17	< 1	385.	< 1	315.	984.	126.	< 0.05	1.	0.	< 1	99.4	81.4	587.
15105503BBB2	< 0.1	45.5	52.5	3.1	112.	2.97	20.4	3.88		7.57	< 1	350.	< 1	287.	763.	53.2	23.7	467.	27.	168.	0.0	0.00	498.
15105504AAA	49.3	27.8	30.5	3.4	74.2	0.655	1.04	11.6		7.70	< 1	325.	< 1	266.	806.	143.	0.17	300.	18.	10.0	26.0	1.24	472.
15105511DCD2	3.2	47.2	40.5	1.4	160.	0.599	6.76	8.40		7.57	< 1	409.	< 1	335.	1120	39.0	62.1	594.	35.	124.	1.1	0.06	739.
15105512ACC	< 0.1	29.1	32.7	1.6	103.	4.87	6.24	8.55		7.37	< 1	370.	< 1	303.	728.	83.3	< 0.05	377.	22.	1.60	0.1	0.00	410.
15105513AAA	18.2	17.4	34.6	5.2	86.8	0.842	6.90	3.51		7.32	< 1	367.	< 1	301.	657.	65.9	< 0.05	289.	17.	34.0	11.8	0.47	380.
15105515AAA	27.9	36.2	34.4	5.0	166.	1.56	1.85	36.1		7.24	< 1	311.	< 1	255.	1160	326.	< 0.05	564.	33.	20.0	9.6	0.51	752.
15105523CCC	32.9	33.5	32.3	6.9	143.	1.41	4.43	38.4		7.32	< 1	339.	< 1	278.	1100	276.	< 0.05	495.	29.	29.5	12.4	0.64	700.
15105524AAA	4.0	16.4	30.3	3.6	84.1	1.12	0.652	3.46		7.43	< 1	331.	< 1	271.	574.	40.6	0.14	278.	16.	3.90	3.0	0.10	318.
15105524CCC	75.4	29.5	30.1	8.5	125.	0.608	1.97	7.34		7.28	< 1	385.	< 1	315.	1160	307.	< 0.05	434.	25.	17.0	26.8	1.57	744.
15205504BBB	60.5	27.5	33.4	6.8	112.	0.746	0.835	33.1		7.41	< 1	303.	< 1	248.	936.	211.	< 0.05	393.	23.	4.10	24.6	1.33	602.
15205505CDC	30.9	32.2	29.5	4.6	113.	0.494	1.24	13.3		7.38	< 1	319.	< 1	261.	964.	252.	< 0.05	415.	24.	12.0	13.7	0.66	605.
15205510DDD	32.9	27.3	33.2	5.7	133.	1.30	1.42	14.9		7.27	< 1	350.	< 1	287.	933.	215.	< 0.05	445.	26.	12.0	13.6	0.68	603.
15205515BBB	34.3	28.1	32.4	3.6	127.	0.657	6.41	13.0		7.47	< 1	341.	< 1	279.	984.	270.	< 0.05	433.	25.	33.0	14.5	0.72	646.
15205516DDD	59.7	24.1	34.8	4.8	120.	0.869	1.60	13.1		7.27	< 1	351.	< 1	287.	956.	223.	< 0.05	399.	23.	15.0	24.2	1.30	620.
15205520AAA	8.1	15.2	37.7	1.2	66.7	0.565	4.31	8.65		7.71	< 1	217.	< 1	178.	454.	68.5	< 0.05	229.	13.	52.0	7.1	0.23	277.
15205521DDD	31.2	159.	52.8	2.3	189.	0.347	7.54	163.	0.73	7.15	< 1	605.	< 1	495.	2080	279.	54.4	1130	66.	92.0	5.6	0.40	1370
15205522DDD	38.0	28.7	44.0	7.0	135.	1.43	6.85	14.1		7.34	< 1	344.	< 1	282.	927.	226.	< 0.05	456.	27.	78.0	15.0	0.77	620.
15205527DDD	16.2	20.1	31.2	4.6	77.9	0.932	10.1	10.2		7.49	< 1	303.	< 1	248.	619.	74.0	< 0.05	277.	16.	68.0	11.0	0.42	354.
15205535CCC	13.0	15.1	42.5	3.8	73.8	1.70	13.9	5.88		7.62	< 1	262.	< 1	215.	517.	57.4	< 0.05	247.	14.	148.	10.1	0.36	300.
15305504CCD	2.7	23.1	34.2	4.5	111.	1.30	5.64	7.56		7.37	< 1	400.	< 1	328.	723.	64.8	< 0.05	373.	22.	56.0	1.5	0.06	413.
15305505CDD	37.9	27.2	28.7	5.6	99.7	1.09	0.987	14.7		7.43	< 1	371.	< 1	304.	880.	162.	< 0.05	361.	21.	10.0	18.2	0.87	532.
15305506AAA	44.5	24.3	37.2	4.8	87.2	0.687	4.89	13.9		7.50	< 1	347.	< 1	284.	756.	111.	< 0.05	318.	19.	49.0	22.9	1.08	459.
15305507BCC	90.0	45.3	31.3	3.3	133.	0.559	1.28	35.7		7.31	< 1	339.	< 1	278.	1330	305.	< 0.05	519.	30.	13.0	27.1	1.72	781.
15305508AAA	24.2	23.2	32.5	5.8	117.	0.895	2.84	10.9		7.31	< 1	462.	< 1	378.	850.	113.	< 0.05	388.	23.	28.0	11.7	0.53	524.
15305509CDD	18.8	46.5	28.6	8.2	181.	2.44	8.71	< 0.3		7.04	< 1	718.	< 1	588.	1240	1.5	< 0.05	644.	38.	52.0	5.9	0.32	612.
15305515CCC	17.9	44.6	33.6	10.9	150.	1.98	27.2	13.2		6.99	< 1	438.	< 1	359.	968.	177.	< 0.05	559.	33.	180.	6.3	0.33	631.
15305516DAA	< 0.1	38.3	33.2	2.8	87.2	0.785	4.30	1.95		7.41	< 1	431.	< 1	353.	662.	41.4	< 0.05	376.	22.	30.0	0.1	0.00	386.
15305517BBB	84.9	44.7	26.5	4.5	145.	1.08	6.11	57.6		7.33	< 1	403.	< 1	330.	1390	376.	< 0.05	546.	32.	52.0	25.0	1.58	913.
15305527BBB	15.2	27.2	32.7	5.2	129.	1.79	7.41	11.7		7.22	< 1	491.	< 1	402.	885.	110.	< 0.05	434.	25.	37.0	6.9	0.32	542.
15305529BAA	157.	79.7	29.3	5.1	196.	0.022	0.361	111.	0.75	7.30	< 1	489.	< 1	400.	2100	617.	1.75	818.	48.	2.00	29.2	2.39	1420
15305530AAA	167.	13.3	28.6	8.2	53.2	0.256	0.203	12.8		7.56	< 1	467.	< 1	382.	1180	160.	< 0.05	188.	11.	2.70	64.6	5.30	647.
15305532AAA	39.0	29.4	28.9	4.2	112.	0.155	3.26	12.9		7.51	< 1	384.	< 1	314.	918.	159.	9.29	401.	23.	24.0	17.2	0.85	589.
15305534BBB	47.4	26.1	68.5	4.5	94.4	2.87	27.9	9.12		7.42	< 1	344.	< 1	282.	790.	141.	< 0.05	343.	20.	132.	22.7	1.11	494.
15305535BBB	18.0	102.	29.6	9.2	312.	0.748	33.3	70.1	0.13	6.83	< 1	596.	< 1	488.	2010	672.	< 0.05	1200	70.	175.	3.1	0.23	1480
15405508CCC	< 0.1	36.8	38.6	3.2	109.	1.90	7.20	1.71		7.35	< 1	409.	< 1	335.	698.	66.6	< 0.05	424.	25.	93.0	0.1	0.00	421.
15405517CCC	21.6	18.9	26.0	9.6	91.7	1.45	1.15	4.34		7.34	< 1	336.	< 1	275.	692.	97.0	< 0.05	307.	18.	6.50	12.8	0.54	411.

All units reported in mg/l except: pH, Conductivity (umhos/cm), Hardness (gr/gal), Turbidity (NTU), % Na (%), and SAR (Sodium Adsorption ration).
CaCO3 is total hardness measured as calcium carbonate.

*** Elk Valley Aquifer *** (continued)

WELL ID (TRSQ)	Na	Mg	SiO2	K	Ca	Mn	Fe	Cl	F	pH	CO3	HCO3	OH	Alk.	Cond.	SO4	NO3	CaCO3	Hard.	Turb.	% Na	SAR	TDS
15405518BBB	25.9	14.6	30.0	4.6	54.6	0.743	1.29	6.64		7.43	< 1	233.	< 1	191.	521.	78.8	< 0.05	197.	11.	11.0	21.7	0.80	302.
15405520CDD	2.5	30.0	34.4	4.4	110.	0.849	3.72	1.43		7.32	< 1	354.	< 1	290.	732.	122.	< 0.05	398.	23.	38.0	1.3	0.05	447.
15405522ADD	0.9	33.5	32.2	3.0	112.	0.796	2.16	14.9		7.35	< 1	264.	< 1	216.	765.	186.	< 0.05	418.	24.	28.0	0.5	0.02	482.
15405528CCC	1.5	18.2	40.9	4.2	90.5	0.928	4.99	0.80		7.50	< 1	317.	< 1	260.	496.	18.5	< 0.05	301.	18.	54.0	1.0	0.04	292.
15405529ABB	2.2	18.5	29.8	2.9	96.9	0.796	1.78	8.69		7.29	< 1	289.	< 1	237.	647.	102.	< 0.05	318.	19.	14.0	1.5	0.05	376.
15405529BBB	25.5	33.0	37.1	6.9	123.	2.00	7.98	3.56		7.29	< 1	438.	< 1	359.	797.	84.5	< 0.05	443.	26.	64.0	10.9	0.53	494.
15405530DDA2	0.7	16.2	28.3	2.4	60.4	1.13	0.767	3.64		7.71	< 1	217.	< 1	178.	447.	36.8	6.62	218.	13.	6.10	0.7	0.02	258.
15405531CCC	42.3	28.6	31.1	3.0	75.6	0.547	2.55	3.61		7.43	< 1	443.	< 1	363.	719.	51.2	< 0.05	307.	18.	20.0	22.8	1.05	425.
15405532BBC2	16.4	20.5	29.4	3.3	63.9	0.375	1.10	0.90		7.85	< 1	349.	< 1	286.	538.	11.5	1.90	244.	14.	7.50	12.5	0.46	299.
15405533CCC2	8.5	77.6	50.4	8.3	174.	0.578	9.59	7.67		7.38	< 1	364.	< 1	298.	1130	348.	0.81	754.	44.	102.	2.3	0.13	809.
15405613BBC	29.2	32.3	30.9	5.4	103.	0.597	1.02	30.0		7.39	< 1	265.	< 1	217.	876.	209.	< 0.05	390.	23.	8.00	13.7	0.64	542.
15405623DDD	17.9	19.9	32.6	4.9	71.5	0.350	0.434	24.9		7.56	< 1	239.	< 1	196.	612.	89.4	< 0.05	261.	15.	4.60	12.7	0.48	348.
15405625AAA	35.1	31.8	75.8	15.7	76.2	0.680	10.3	11.7		7.36	< 1	355.	< 1	291.	749.	116.	< 0.05	321.	19.	104.	18.2	0.85	463.
MINIMUM	< 0.1	< 0.1	25.3	< 1	0.1	< 0.002	0.046	< 0.3	0.12	6.83	< 1	217.	< 1	178.	414.	1.5	< 0.05	1.	0.	< 1	0.0	0.00	232.
MAXIMUM	218.	230.	75.8	15.7	535.	5.62	50.8	163.	1.01	7.85	< 1	747.	< 1	612.	2660	1610	62.1	1850	108.	370.	99.5	106.	2440
MEAN	30.2	41.6	35.6	5.2	135.6	1.257	6.22	15.6	0.44	7.34	0.5	386	0.5	316	1007.5	234	2.28	510	30	54	11.4	2.6	665
MEDIAN	17.9	29.5	32.7	4.8	112.0	0.939	3.44	8.7	0.20	7.35	0.5	359	0.5	294	837.5	111	0.01	401	23	28	6.9	0.4	496
STDDEV	41.4	36.0	10.0	2.9	81.3	0.981	8.69	24.7	0.38	0.19	0.0	110	0.0	90	504.9	310	9.21	328	19	68	16.7	14.1	440

*** Fordville Aquifer ***

WELL ID (TRSQ)	Na	Mg	SiO2	K	Ca	Mn	Fe	Cl	F	pH	CO3	HCO3	OH	Alk.	Cond.	SO4	NO3	CaCO3	Hard.	Turb.	% Na	SAR	TDS
15505530BBB	10.1	24.5	59.9	3.0	73.1	3.79	21.7	3.11		7.70	< 1	254.	< 1	208.	580.	93.4	0.88	284.	17.	256.	7.1	0.26	338.
15505611DDD	13.8	25.9	55.3	2.1	67.6	1.76	8.44	1.04		7.43	< 1	355.	< 1	291.	573.	17.6	< 0.05	276.	16.	40.0	9.7	0.36	305.
15505612CCD	15.8	35.4	42.4	5.0	99.3	1.20	8.71	10.8		7.63	< 1	297.	< 1	243.	767.	146.	< 0.05	394.	23.	92.0	7.9	0.35	461.
15505625ADD2	6.2	33.2	88.1	3.0	95.7	25.4	163.	3.16		7.37	< 1	297.	< 1	243.	664.	81.0	8.08	376.	22.	720.	3.4	0.14	407.
15505625BBB	4.2	29.3	36.1	3.0	92.1	1.39	6.52	6.63		7.64	< 1	245.	< 1	201.	678.	145.	< 0.05	351.	20.	100.	2.5	0.10	403.
15505625BBB	5.5	34.5	37.4	4.0	105.	1.28	5.16	13.4		7.18	< 1	278.	< 1	228.	697.	150.	< 0.05	404.	24.	1000	2.8	0.12	451.
15605616DDC	< 0.1	14.1	141.	23.0	45.1	8.19	103.	4.95		7.29	< 1	245.	< 1	201.	385.	6.74	<0.05	171.	10.	960.	0.1	0.00	217.
15605622BAD	36.5	27.3	68.9	3.5	88.1	5.14	28.0	17.1		7.47	< 1	340.	< 1	278.	706.	104.	0.13	333.	19.	350.	19.0	0.87	447.
15605626DCC	24.8	33.1	34.8	4.2	98.9	0.672	1.34	11.2		7.47	< 1	308.	< 1	252.	841.	184.	< 0.05	383.	22.	18.0	12.1	0.55	510.
15605634DCC	55.9	18.1	28.6	4.9	64.9	0.581	0.703	5.82		7.68	< 1	313.	< 1	256.	718.	117.	< 0.05	237.	14.	13.0	33.2	1.58	423.
15605636CCC	20.6	33.0	109.	8.5	110.	10.0	141.	11.6		7.85	< 1	346.	< 1	283.	794.	130.	< 0.05	411.	24.	552.	9.6	0.44	486.
MINIMUM	< 0.1	14.1	28.6	2.1	45.1	0.581	0.703	1.04		7.18	< 1	245.	< 1	201.	385.	6.7	< 0.05	171.	10.	13.0	0.1	0.00	217.
MAXIMUM	55.9	35.4	141.	23.0	110.	25.4	163.	17.1		7.85	< 1	355.	< 1	291.	841.	184.	8.08	411.	24.	1000	33.2	1.58	510.
MEAN	17.6	28.0	63.8	5.8	85.4	5.400	44.32	8.1	.	7.52	0.5	298	0.5	244	673.0	107	0.84	329	19	373	9.8	0.4	404
MEDIAN	13.8	29.3	55.3	4.0	92.1	1.760	8.71	6.6	.	7.47	0.5	297	0.5	243	697.0	117	0.01	351	20	256	7.9	0.4	423
STDDEV	16.5	7.0	35.6	5.9	20.1	7.356	60.76	5.0	.	0.20	0.0	39	0.0	32	125.3	55	2.42	78	5	377	9.4	0.5	86

All units reported in mg/l except: pH, Conductivity (umhos/cm), Hardness (gr/gal), Turbidity (NTU), % Na (%), and SAR (Sodium Adsorption ration).
CaCO3 is total hardness measured as calcium carbonate.

*** Inkster Aquifer ***

WELL ID (TRSQ)	Na	Mg	SiO2	K	Ca	Mn	Fe	Cl	F	pH	CO3	HCO3	OH	Alk.	Cond.	SO4	NO3	CaCO3	Hard.	Turb.	% Na	SAR	TDS
15305514DCC	126.	16.7	30.5	7.9	67.4	0.331	0.432	4.90		7.57	< 1	444.	< 1	364.	1020	171.	< 0.05	237.	14.	4.20	52.4	3.56	615.
15405509DDD	1.6	31.8	30.7	2.9	104.	0.539	0.503	3.67		7.47	< 1	288.	< 1	236.	762.	171.	< 0.05	391.	23.	7.00	0.9	0.04	459.
15405510CDCDC	13.9	74.6	27.8	5.2	323.	2.33	0.470	10.5		7.16	< 1	292.	< 1	239.	1880	917.	< 0.05	1110	65.	5.90	2.6	0.18	1490
15405514CDC2	< 0.1	18.0	42.2	1.3	58.5	0.676	4.57	0.66		7.67	< 1	233.	< 1	191.	407.	29.0	1.02	220.	13.	58.0	0.1	0.00	229.
15405515ADAA	< 0.1	22.3	36.6	1.6	80.0	0.578	5.03	4.73		7.68	< 1	235.	< 1	192.	534.	49.5	5.61	292.	17.	52.0	0.1	0.00	301.
15405522BAA	0.3	40.7	28.2	2.4	130.	0.604	0.282	22.6		7.42	< 1	281.	< 1	230.	929.	258.	< 0.05	492.	29.	3.70	0.1	0.01	595.
15405523DBB2	1.0	24.6	26.5	2.2	89.4	0.495	0.144	5.15		7.44	< 1	259.	< 1	212.	635.	137.	< 0.05	325.	19.	1.40	0.7	0.02	389.
15405528DDD	< 0.1	21.6	35.8	3.7	95.6	0.755	2.66	1.14		7.46	< 1	371.	< 1	304.	607.	23.2	< 0.05	328.	19.	24.0	0.1	0.00	330.
MINIMUM	< 0.1	16.7	26.5	1.3	58.5	0.331	0.144	0.66		7.16	< 1	233.	< 1	191.	407.	23.2	< 0.05	220.	13.	1.40	0.1	0.00	229.
MAXIMUM	126.	74.6	42.2	7.9	323.	2.33	5.03	22.6		7.68	< 1	444.	< 1	364.	1880	917.	5.61	1110	65.	58.0	52.4	3.56	1490
MEAN	17.9	31.3	32.3	3.4	118.5	0.789	1.76	6.7	.	7.48	0.5	300	0.5	246	846.8	219	0.84	424	25	20	7.1	0.5	551
MEDIAN	0.7	23.5	30.6	2.7	92.5	0.591	0.49	4.8	.	7.47	0.5	285	0.5	233	698.5	154	0.01	327	19	6	0.4	0.0	424
STDDEV	43.9	19.2	5.4	2.2	85.5	0.635	2.04	7.1	.	0.17	0.0	72	0.0	60	463.7	294	1.96	290	17	23	18.3	1.2	403

*** Karlsruhe Aquifer ***

WELL ID (TRSQ)	Na	Mg	SiO2	K	Ca	Mn	Fe	Cl	F	pH	CO3	HCO3	OH	Alk.	Cond.	SO4	NO3	CaCO3	Hard.	Turb.	% Na	SAR	TDS
15307705BAA2	3.9	20.9	32.0	1.7	74.9	0.410	1.77	2.16		7.51	< 1	255.	< 1	209.	511.	64.2	< 0.05	273.	16.	16.0	3.0	0.10	295.
15307706DCC	22.3	11.8	24.6	1.2	35.5	9.16	431.	2.34		7.98	< 1	209.	< 1	171.	328.	14.9	< 0.05	137.	8.	2700	25.8	0.83	193.
15307706DCC	29.1	19.7	121.	2.1	55.0	3.22	127.	2.45		7.09	< 1	289.	< 1	237.	476.	42.3	< 0.05	219.	13.	1480	22.2	0.86	295.
15307707CBB	5.5	25.6	200.	1.6	75.5	26.0	752.	4.04		7.14	< 1	367.	< 1	301.	509.	5.69	0.55	294.	17.	6880	3.9	0.14	303.
15307708DDA	161.	46.5	73.4	10.5	69.4	0.636	21.9	12.8		7.57	< 1	697.	< 1	571.	1170	84.3	< 0.05	365.	21.	140.	48.0	3.66	730.
15307717BCB	61.7	21.9	34.8	4.6	67.1	0.210	5.23	14.0		7.54	< 1	350.	< 1	287.	735.	92.7	< 0.05	258.	15.	32.0	33.6	1.67	437.
15307720BBB	175.	26.9	45.1	5.6	75.8	0.486	8.76	22.1		7.63	< 1	574.	< 1	470.	1170	138.	< 0.05	300.	18.	64.0	55.2	4.39	728.
15307801DAD	21.1	25.4	19.2	1.8	76.7	46.2	750.	0.97		7.61	< 1	373.	< 1	305.	575.	23.8	< 0.05	296.	17.	3200	13.3	0.53	336.
15307812BAB	108.	52.5	89.2	4.4	124.	1.17	30.1	10.2		7.47	< 1	810.	< 1	663.	1330	90.2	< 0.05	526.	31.	310.	30.5	2.05	790.
15407730DDD3	1.4	20.3	37.7	2.1	72.1	1.49	5.65	0.85		7.67	< 1	295.	< 1	242.	452.	19.0	1.47	264.	15.	74.0	1.1	0.04	270.
15407731ABB2	5.1	36.3	35.7	2.4	125.	0.063	1.98	33.3		7.93	< 1	316.	< 1	259.	968.	56.8	42.7	462.	27.	32.0	2.3	0.10	607.
15407731ABB3	2.9	39.6	110.	2.3	139.	11.2	334.	43.2		7.92	< 1	243.	< 1	199.	981.	59.2	44.6	510.	30.	1200	1.2	0.06	606.
15407732CBC3	5.1	34.3	98.7	2.2	131.	9.51	394.	39.1		8.03	< 1	238.	< 1	195.	905.	90.8	30.7	469.	27.	1200	2.3	0.10	558.
15407732DAD2	16.3	24.0	30.3	2.3	85.5	0.411	2.10	14.4		7.56	< 1	298.	< 1	244.	635.	85.4	< 0.05	313.	18.	16.0	10.1	0.40	377.
15407825CDD	2.5	34.3	44.3	2.4	115.	0.287	6.77	48.2		7.49	< 1	205.	< 1	168.	837.	65.7	41.3	429.	25.	80.0	1.2	0.05	555.
15407826CDD	10.0	51.1	90.1	6.0	168.	0.781	35.8	30.2		7.51	< 1	254.	< 1	208.	1100	75.6	74.3	630.	37.	260.	3.3	0.17	799.
15407826DAD3	20.9	30.3	96.6	2.8	102.	9.13	307.	33.0		7.62	< 1	268.	< 1	219.	782.	78.2	20.1	380.	22.	1900	10.6	0.47	491.
15407826DAD3	15.9	34.3	29.5	2.8	107.	0.334	7.84	36.7		7.49	< 1	241.	< 1	197.	800.	84.3	18.9	409.	24.	87.8	7.7	0.34	486.
15407827DDA2	8.6	40.4	105.	2.8	129.	1.20	37.9	45.6		7.42	< 1	203.	< 1	166.	1060	67.0	59.3	489.	29.	320.	3.6	0.17	659.
15407827DDA2	7.5	38.9	38.3	3.0	121.	0.202	6.56	48.4		7.50	< 1	187.	< 1	153.	926.	59.7	45.7	463.	27.	83.6	3.4	0.15	576.
15407835BCC3	22.3	51.0	17.0	4.0	101.	0.421	2.32	14.5		7.43	< 1	603.	< 1	494.	925.	< 0.3	< 0.05	462.	27.	17.0	9.4	0.45	492.
15407836AAA2	12.1	25.0	27.5	1.7	81.7	0.017	1.26	22.8		7.53	< 1	241.	< 1	197.	676.	86.3	8.28	307.	18.	15.0	7.8	0.30	387.
15407836AAA2	13.8	25.8	22.7	1.8	82.1	0.010	0.606	20.8		7.58	< 1	263.	< 1	215.	642.	74.0	7.10	311.	18.	13.0	8.7	0.34	381.
MINIMUM	1.4	11.8	17.0	1.2	35.5	0.010	0.606	0.85		7.09	< 1	187.	< 1	153.	328.	< 0.3	< 0.05	137.	8.	13.0	1.1	0.04	193.
MAXIMUM	175.	52.5	200.	10.5	168.	46.2	752.	48.4		8.03	< 1	810.	< 1	663.	1330	138.	74.3	630.	37.	6880	55.2	4.39	799.
MEAN	31.8	32.0	61.9	3.1	96.2	5.328	142.24	21.8	.	7.57	0.5	338	0.5	277	804.0	63	17.18	372	22	875	13.4	0.8	494
MEDIAN	13.8	30.3	38.3	2.4	85.5	0.636	8.76	20.8	.	7.54	0.5	268	0.5	219	800.0	67	1.47	365	21	88	7.8	0.3	491
STDDEV	48.9	11.2	45.2	2.1	31.4	10.783	236.45	16.5	.	0.23	0.0	168	0.0	138	266.0	33	23.04	117	7	1599	15.4	1.2	176

All units reported in mg/l except: pH, Conductivity (umhos/cm), Hardness (gr/gal), Turbidity (NTU), % Na (%), and SAR (Sodium Adsorption ration).
CaCO3 is total hardness measured as calcium carbonate.

*** Lake Souris Aquifer ***

WELL ID (TRSQ)	Na	Mg	SiO2	K	Ca	Mn	Fe	Cl	F	pH	CO3	HCO3	OH	Alk.	Cond.	SO4	NO3	CaCO3	Hard.	Turb.	% Na	SAR	TDS
15307612DDD2	6.6	19.7	33.8	3.5	71.0	0.515	6.82	0.98		7.41	< 1	340.	< 1	278.	521.	9.3	< 0.05	259.	15.	50.0	5.2	0.18	281.
15407605BAB	16.7	27.0	29.9	2.4	88.9	0.274	4.44	3.27		7.31	< 1	503.	< 1	412.	701.	4.7	< 0.05	333.	19.	33.0	9.7	0.40	393.
15407608DDD	69.5	23.1	29.4	5.5	84.2	0.281	4.46	10.9		7.34	< 1	583.	< 1	477.	871.	16.0	< 0.05	306.	18.	34.0	32.5	1.73	498.
15407615CDD2	8.7	11.4	28.2	2.2	52.8	0.252	1.62	2.86		7.36	< 1	260.	< 1	213.	413.	13.3	< 0.05	179.	10.	16.0	9.4	0.28	222.
15407616DDC	83.5	34.8	35.0	4.9	63.2	0.139	7.12	13.0		7.45	< 1	627.	< 1	514.	912.	0.5	< 0.05	301.	18.	64.0	37.0	2.09	511.
15407618CCC	3.2	18.3	28.5	1.3	66.1	0.310	4.41	0.43		7.31	< 1	286.	< 1	234.	472.	26.0	< 0.05	241.	14.	20.0	2.8	0.09	258.
15407619DCC	8.0	23.2	39.1	1.9	82.3	0.367	9.38	5.05		7.29	< 1	335.	< 1	274.	564.	31.5	< 0.05	301.	18.	56.0	5.4	0.20	319.
15407620CDD2	12.3	26.5	39.9	2.1	82.6	0.481	7.50	1.58		7.38	< 1	357.	< 1	292.	586.	42.3	< 0.05	316.	18.	120.	7.7	0.30	345.
15407621CCC2	27.8	28.8	40.8	3.6	80.0	0.322	28.9	11.9		7.26	< 1	451.	< 1	369.	697.	39.2	< 0.05	319.	19.	175.	15.7	0.68	416.
15407622DDA	0.4	10.0	31.7	1.6	52.9	0.267	2.52	1.10		7.60	< 1	219.	< 1	179.	337.	6.3	< 0.05	173.	10.	22.0	0.5	0.01	182.
15407701AAA2	72.4	44.3	51.9	5.9	80.7	0.538	12.6	16.9		7.39	< 1	698.	< 1	572.	962.	< 0.3	< 0.05	384.	22.	96.0	28.6	1.61	566.
15407702CCD2	< 0.1	23.8	47.4	1.6	77.5	0.476	7.49	23.2		7.51	< 1	298.	< 1	244.	557.	27.0	7.26	292.	17.	128.	0.1	0.00	334.
15407711BCC	9.8	23.2	24.0	2.0	71.7	0.207	0.467	3.46		7.53	< 1	312.	< 1	256.	515.	45.0	0.12	275.	16.	5.60	7.1	0.26	311.
15507621AAA	29.8	43.2	36.9	3.9	199.	0.768	10.2	11.6		7.17	< 1	564.	< 1	462.	1340	287.	< 0.05	675.	39.	76.0	8.7	0.50	854.
15507628BBB	11.1	24.8	37.9	3.0	80.2	0.212	14.0	0.69		7.24	< 1	416.	< 1	341.	618.	33.6	< 0.05	303.	18.	62.0	7.3	0.28	360.
15507631DCC	47.1	30.9	28.8	4.1	89.1	0.209	3.93	14.5		7.47	< 1	608.	< 1	498.	861.	9.0	< 0.05	350.	20.	37.0	22.3	1.09	496.
15507717AAA	3.0	20.1	60.5	3.5	76.2	0.598	43.4	0.75		7.50	< 1	297.	< 1	243.	411.	9.8	< 0.05	273.	16.	144.	2.3	0.08	262.
15507725AAA	3.0	18.4	29.2	1.0	72.4	0.384	2.77	0.71		7.38	< 1	323.	< 1	265.	451.	12.2	< 0.05	257.	15.	24.0	2.5	0.08	269.
15507726BAA	14.4	16.9	30.6	2.6	47.9	0.118	6.80	7.41		7.58	< 1	278.	< 1	228.	451.	5.4	< 0.05	189.	11.	27.0	13.9	0.46	234.
15507734DD	39.9	40.4	24.3	5.2	41.1	0.091	4.76	7.41		7.55	< 1	466.	< 1	382.	678.	< 0.3	< 0.05	269.	16.	52.0	23.9	1.06	366.
15507735DCC	46.1	31.9	33.7	3.6	59.3	0.319	8.91	3.19		7.32	< 1	490.	< 1	401.	684.	1.89	0.09	280.	16.	48.0	26.0	1.20	390.
15507735DCC2	13.7	20.7	29.4	3.1	46.6	0.392	2.18	3.78		7.59	< 1	277.	< 1	227.	447.	9.34	2.69	202.	12.	34.0	12.6	0.42	248.
15507810CBB	155.	2.5	25.8	3.3	9.65	0.029	0.133	10.7		8.08	< 1	460.	< 1	377.	746.	18.7	< 0.05	34.	2.	1.40	89.7	11.5	429.
15807620CBB	99.1	49.0	48.9	7.2	182.	1.01	8.79	2.84		7.02	< 1	809.	< 1	663.	1220	92.0	< 0.05	657.	38.	275.	24.4	1.68	833.
15807621BAA	20.6	39.9	75.9	3.9	143.	0.848	20.2	1.93		6.98	< 1	589.	< 1	482.	798.	9.8	< 0.05	522.	30.	237.	7.8	0.39	511.
15807635CCC	11.6	41.3	125.	2.6	82.4	6.72	244.	8.16		6.81	< 1	458.	< 1	375.	662.	21.1	< 0.05	376.	22.	2900	6.2	0.26	395.
15807709ADD	21.3	39.4	39.6	3.8	97.6	0.390	10.4	1.25		6.89	< 1	390.	< 1	319.	718.	103.	0.23	406.	24.	169.	10.1	0.46	461.
15807711BBB	10.1	28.3	127.	3.0	82.4	4.93	117.	3.03		6.81	< 1	418.	< 1	342.	580.	14.0	< 0.05	322.	19.	2030	6.3	0.24	349.
15807715DCC	513.	8.1	25.8	7.6	25.3	0.024	1.61	503.	0.64	8.02	< 1	831.	< 1	681.	2670	< 0.3	< 0.05	97.	6.	6.90	91.3	22.7	1470
15807723CBB	368.	282.	15.7	208.	325.	1.54	0.582	811.	0.25	7.02	< 1	1340	< 1	1100	5670	1130	15.2	1970	115.	6.30	26.2	3.60	3850
15907510ACB	4.4	49.3	46.2	3.9	93.3	0.737	18.4	2.78		7.27	< 1	324.	< 1	265.	654.	112.	0.13	436.	25.	242.	2.1	0.09	428.
15907524BBB	69.1	25.3	38.1	5.1	72.7	0.430	5.51	7.91		7.04	< 1	452.	< 1	370.	740.	52.5	< 0.05	286.	17.	125.	33.8	1.78	457.
15907526AAA	73.3	47.6	22.3	6.3	111.	0.588	0.513	12.8		6.92	< 1	397.	< 1	325.	1070	280.	< 0.05	473.	28.	10.5	24.8	1.46	729.
MINIMUM	< 0.1	2.5	15.7	1.0	9.65	0.024	0.133	0.43	0.25	6.81	< 1	165.	< 1	135.	337.	< 0.3	< 0.05	34.	2.	1.40	0.1	0.00	182.
MAXIMUM	513.	282.	127.	208.	325.	6.72	244.	811.	0.64	8.08	< 1	1340	< 1	1100	5670	1130	15.2	1970	115.	2900	91.3	22.7	3850
MEAN	56.7	35.6	41.2	9.8	87.6	0.750	18.84	45.8	0.45	7.33	0.5	468	0.5	378	896.3	75	0.78	365	21	222	18.3	1.7	546
MEDIAN	16.7	26.5	33.8	3.5	80.0	0.384	6.82	3.78	0.45	7.34	0.5	418	0.5	369	678.0	16	0.01	301	18	52	9.7	0.4	393
STDDEV	106.8	45.8	24.8	35.6	56.7	1.360	45.43	162.2	0.28	0.30	0.0	226	0.0	185	951.6	201	5.97	317	18	593	21.6	4.3	641

All units reported in mg/l except: pH, Conductivity (umhos/cm), Hardness (gr/gal), Turbidity (NTU), % Na (%), and SAR (Sodium Adsorption ration).
CaCO3 is total hardness measured as calcium carbonate.

*** McVille Aquifer ***

WELL ID (TRSQ)	Na	Mg	SiO2	K	Ca	Mn	Fe	Cl	F	pH	CO3	HCO3	OH	Alk.	Cond.	SO4	NO3	CaCO3	Hard.	Turb.	% Na	SAR	TDS
14605826BCB	178.	9.7	27.4	7.0	46.2	0.533	0.313	32.7		7.58	< 1	391.	< 1	320.	1150	217.	< 0.05	155.	9.	1.90	70.1	6.21	685.
14905903AAA	< 0.1	10.7	33.2	1.0	47.5	0.540	0.129	1.07		7.58	< 1	191.	< 1	156.	340.	22.9	< 0.05	163.	10.	2.20	0.1	0.00	179.
15005921BCC2	2.5	16.6	41.6	2.4	65.5	0.904	6.39	1.64		7.51	< 1	266.	< 1	218.	466.	30.9	< 0.05	232.	14.	39.0	2.2	0.07	253.
15005935CB	17.2	21.4	30.7	2.1	87.8	0.625	0.100	7.28		7.30	< 1	285.	< 1	233.	578.	74.6	< 0.05	308.	18.	2.30	10.7	0.43	353.
15006005AAC2	203.	28.1	83.3	6.8	83.0	2.38	27.1	52.0		7.43	< 1	482.	< 1	395.	1340	247.	< 0.05	323.	19.	234.	57.0	4.91	859.
15006014CBB	19.1	17.0	31.1	3.0	81.9	0.057	< 0.007	4.66		7.69	< 1	351.	< 1	287.	641.	51.4	0.21	275.	16.	1.10	12.9	0.50	353.
15006016AAD	15.7	21.4	33.3	3.9	111.	1.10	0.290	6.27		7.23	< 1	366.	< 1	300.	735.	86.3	0.06	366.	21.	2.00	8.4	0.36	427.
15006023ADC	17.0	33.8	31.3	3.7	129.	1.18	3.49	3.76		7.23	< 1	429.	< 1	351.	948.	172.	0.07	462.	27.	16.0	7.3	0.34	573.
15006024AAA	36.3	42.2	63.3	5.9	115.	1.31	17.6	7.41		7.30	< 1	461.	< 1	378.	937.	134.	< 0.05	461.	27.	104.	14.4	0.73	570.
MINIMUM	< 0.1	9.7	27.4	1.0	46.2	0.057	< 0.007	1.07		7.23	< 1	191.	< 1	156.	340.	22.9	< 0.05	155.	9.	1.10	0.1	0.00	179.
MAXIMUM	203.	42.2	83.3	7.0	129.	2.38	27.1	52.0		7.69	< 1	482.	< 1	395.	1340	247.	0.21	462.	27.	234.	70.1	6.21	859.
MEAN	54.3	22.3	41.7	4.0	85.2	0.959	6.16	13.0	.	7.43	0.5	358	0.5	293	792.8	115	0.04	305	18	45	20.3	1.5	472
MEDIAN	17.2	21.4	33.2	3.7	83.0	0.904	0.31	6.3	.	7.43	0.5	366	0.5	300	735.0	86	0.01	308	18	2	10.7	0.4	427
STDDEV	78.2	10.7	19.0	2.1	29.2	0.661	9.72	17.5	.	0.17	0.0	96	0.0	79	327.2	82	0.07	113	6	79	25.1	2.3	218

*** New Rockford Aquifer ***

WELL ID (TRSQ)	Na	Mg	SiO2	K	Ca	Mn	Fe	Cl	F	pH	CO3	HCO3	OH	Alk.	Cond.	SO4	NO3	CaCO3	Hard.	Turb.	% Na	SAR	TDS
15207509DDC	74.8	19.1	58.9	4.4	58.2	0.304	15.8	2.45		7.95	< 1	462.	< 1	378.	714.	43.5	< 0.05	224.	13.	108.	41.3	2.17	432.
15207533ABA	10.5	19.9	49.1	7.3	79.8	0.822	4.77	1.38		7.40	< 1	339.	< 1	278.	568.	31.9	< 0.05	281.	16.	44.0	7.3	0.27	320.
15207536BBB2	3.9	18.8	30.9	3.9	71.2	0.463	8.66	3.94		7.20	< 1	324.	< 1	265.	538.	27.6	< 0.05	255.	15.	80.0	3.1	0.11	291.
15307606CCC	257.	33.9	37.2	12.1	94.6	0.307	3.77	15.3		7.85	< 1	954.	< 1	781.	1750	202.	< 0.05	376.	22.	28.0	58.7	5.76	1090
15407727ADD	59.8	16.9	103.	4.2	49.6	1.41	59.4	3.31		7.87	< 1	375.	< 1	307.	582.	9.3	< 0.05	194.	11.	429.	39.4	1.87	330.
15407729DDA	231.	19.9	36.6	6.4	60.4	0.332	4.43	9.20		7.99	< 1	647.	< 1	530.	1440	251.	< 0.05	233.	14.	25.0	67.5	6.58	899.
15407729DDA	246.	24.3	43.7	7.4	70.3	0.487	9.55	9.26		7.67	< 1	631.	< 1	517.	1410	235.	< 0.05	276.	16.	136.	65.1	6.44	905.
15407730DDD2	178.	18.9	27.4	6.6	66.1	0.183	0.999	12.3		7.90	< 1	473.	< 1	387.	1260	270.	< 0.05	243.	14.	6.90	60.5	4.96	787.
15407730DDD2	181.	19.2	24.6	6.8	64.2	0.193	1.01	11.7		7.62	< 1	456.	< 1	373.	1190	238.	< 0.05	240.	14.	8.50	61.2	5.08	748.
15407732BCC1	< 0.1	13.4	19.9	1.5	47.4	0.209	1.08	4.28		7.82	< 1	196.	< 1	161.	343.	13.8	4.06	174.	10.	22.0	0.1	0.00	197.
15407732BCC1	0.5	27.8	16.6	2.4	94.1	0.241	0.560	32.2		7.53	< 1	146.	< 1	120.	723.	71.0	33.8	350.	20.	6.60	0.3	0.01	452.
15407732BCC3	0.8	31.6	28.5	2.8	106.	0.904	11.8	31.0		7.55	< 1	165	< 1	135	736	76.3	30.8	395	23	76.0	0.4	0.02	469
15407733ABB	19.3	25.6	52.2	6.0	90.6	0.714	9.16	2.03		7.57	< 1	390.	< 1	319.	585.	14.9	< 0.05	332.	19.	70.0	11.0	0.46	353.
15407814CCC	71.5	21.1	56.3	5.5	58.5	0.253	23.0	6.91		8.04	< 1	463.	< 1	379.	713.	13.4	< 0.05	233.	14.	93.0	39.2	2.04	407.
15407826BBB2	1.2	36.1	28.5	2.6	160.	0.539	1.60	6.62		7.11	< 1	417.	< 1	342.	940.	200.	< 0.05	549.	32.	8.60	0.5	0.02	614.
15407827CBC2	62.1	28.4	44.0	3.3	81.9	0.255	8.79	11.0		7.71	< 1	381.	< 1	312.	822.	102.	2.88	322.	19.	66.0	29.2	1.51	491.
MINIMUM	< 0.1	13.4	16.6	1.5	47.4	0.183	0.560	1.38		7.11	< 1	146.	< 1	120.	343.	9.3	< 0.05	174.	10.	6.60	0.1	0.00	197.
MAXIMUM	257.	36.1	103.	12.1	160.	1.41	59.4	32.2		8.04	< 1	954.	< 1	781.	1750	270.	33.8	549.	32.	429.	67.5	6.58	1090
MEAN	81.1	23.4	41.1	5.2	78.3	0.476	10.27	10.2	.	7.67	0.5	426	0.5	349	894.6	112	4.47	292	17	75	30.3	2.3	549
MEDIAN	61.0	20.5	36.9	4.95	70.8	0.320	6.72	8.1	.	7.69	0.5	404	0.5	331	729.5	74	0.01	266	16	55	34.2	1.7	461
STDDEV	97.5	6.4	21.3	2.7	27.6	0.328	14.99	7.7	.	0.28	0.0	194	0.0	159	409.5	104	8.68	93	5	106	26.5	2.5	270

All units reported in mg/l except: pH, Conductivity (umhos/cm), Hardness (gr/gal), Turbidity (NTU), % Na (%), and SAR (Sodium Adsorption ration).
CaCO3 is total hardness measured as calcium carbonate.

*** Shell Valley Aquifer ***

WELL ID (TRSQ)	Na	Mg	SiO2	K	Ca	Mn	Fe	Cl	F	pH	CO3	HCO3	OH	Alk.	Cond.	SO4	NO3	CaCO3	Hard.	Turb.	% Na	SAR	TDS
16007107AAA	48.0	19.0	25.8	5.0	48.4	0.879	4.40	4.14		7.52	< 1	382.	< 1	313.	620.	22.7	< 0.05	199.	12.	39.0	33.6	1.48	338.
16007115CCC	1.8	24.7	47.0	2.2	80.1	0.416	8.69	0.92		6.96	< 1	324.	< 1	265.	477.	20.7	< 0.05	302.	18.	191.	1.3	0.05	292.
16007119DDD	47.9	18.7	25.4	5.1	48.0	0.869	4.38	4.17		7.49	< 1	390.	< 1	319.	617.	22.8	< 0.05	197.	12.	38.0	33.8	1.48	341.
16007122DDD	155.	6.6	47.1	4.7	18.2	0.181	10.4	45.9		8.12	< 1	393.	< 1	322.	776.	27.3	< 0.05	73.	4.	92.0	81.0	7.91	453.
16007126AAA	51.0	36.2	27.8	3.7	63.4	0.310	5.03	3.88		7.66	< 1	320.	< 1	262.	849.	118.	24.0	307.	18.	32.0	26.1	1.26	543.
16007129CAB	19.4	17.9	28.2	3.1	70.4	0.241	1.78	3.62		7.25	< 1	340.	< 1	278.	571.	29.6	< 0.05	250.	15.	16.0	14.2	0.53	314.
16007202AAA	121.	57.5	28.7	6.8	103.	0.184	17.8	15.6		7.16	< 1	453.	< 1	371.	1440	443.	< 0.05	494.	29.	144.	34.2	2.37	972.
16007211CBB	277.	16.8	62.2	6.7	31.2	0.499	16.2	64.1		7.96	< 1	607.	< 1	497.	1290	134.	< 0.05	147.	9.	313.	79.4	9.93	831.
16007212DAD	56.0	38.2	35.1	7.3	65.5	0.240	8.64	3.79		7.43	< 1	430.	< 1	352.	842.	121.	< 0.05	321.	19.	75.0	26.8	1.36	506.
16007213DDD	230.	7.1	28.0	5.2	15.3	0.065	4.47	19.1		8.08	< 1	625.	< 1	512.	1120	76.6	< 0.05	67.	4.	21.0	87.0	12.2	663.
16007224CCB	144.	41.5	26.6	5.6	59.7	0.044	4.22	9.30		7.64	< 1	416.	< 1	341.	1080	254.	< 0.05	320.	19.	48.0	48.8	3.50	721.
16107103CCD	22.2	52.4	60.7	5.2	78.2	0.370	184.	5.20		7.18	< 1	354.	< 1	290.	894.	211.	0.49	411.	24.	200.	10.3	0.48	553.
16107108BCB	97.3	43.2	28.8	7.7	125.	0.271	7.00	7.01		7.22	< 1	438.	< 1	359.	1300	379.	< 0.05	490.	29.	58.0	29.6	1.91	877.
16107109ADD	21.3	50.2	30.3	5.7	102.	0.438	0.833	5.20		7.38	< 1	402.	< 1	329.	914.	191.	< 0.05	462.	27.	7.20	9.0	0.43	576.
16107110BBB	49.9	45.5	25.6	5.4	108.	0.095	9.37	6.21		7.37	< 1	388.	< 1	318.	1070	251.	9.17	457.	27.	66.0	18.9	1.01	700.
16107116CDD	19.0	42.3	35.8	4.5	93.9	0.649	3.22	5.70		7.35	< 1	333.	< 1	273.	811.	173.	< 0.05	409.	24.	38.0	9.0	0.41	505.
16107129DAD	9.7	32.7	37.9	3.4	82.3	0.534	5.19	3.00		7.41	< 1	318.	< 1	260.	682.	111.	0.59	340.	20.	34.0	5.7	0.23	403.
16107201DDD	76.2	52.5	31.5	7.0	114.	0.255	4.50	7.64		7.24	< 1	438.	< 1	359.	1200	327.	< 0.05	501.	29.	27.0	24.4	1.48	802.
16107235CDC	100.	49.3	37.9	7.0	141.	0.513	11.0	6.07		7.31	< 1	407.	< 1	333.	1390	466.	< 0.05	555.	32.	72.0	27.7	1.84	972.
MINIMUM	1.8	6.6	25.4	2.2	15.3	0.044	0.833	0.92		6.96	< 1	318.	< 1	260.	477.	20.7	< 0.05	67.	4.	7.20	1.3	0.05	292.
MAXIMUM	277.	57.5	62.2	7.7	141.	0.879	184.	64.1		8.12	< 1	625.	< 1	512.	1440	466.	24.0	555.	32.	313.	87.0	12.2	972.
MEAN	81.4	34.3	35.3	5.3	76.2	0.371	16.37	11.6	.	7.46	0.5	408	0.5	334	944.4	178	1.81	332	20	80	31.6	2.6	598
MEDIAN	51.0	38.2	30.3	5.2	78.2	0.310	5.19	5.7	.	7.38	0.5	393	0.5	322	894.0	134	0.01	321	19	48	26.8	1.5	553
STDDEV	75.6	16.1	11.3	1.5	35.0	0.243	40.84	16.2	.	0.31	0.0	85	0.0	69	291.4	143	5.77	147	9	79	25.6	3.5	220

*** Strawberry Lake Aquifer ***

WELL ID (TRSQ)	Na	Mg	SiO2	K	Ca	Mn	Fe	Cl	F	pH	CO3	HCO3	OH	Alk.	Cond.	SO4	NO3	CaCO3	Hard.	Turb.	% Na	SAR	TDS
14808112DAA	81.8	87.7	63.0	18.1	84.9	0.994	38.8	17.6		7.40	< 1	683.	< 1	559.	1450	269.	< 0.05	573.	33.	220.	22.9	1.49	898.
14908026ABA	135.	44.9	21.7	11.5	85.6	0.187	7.23	5.05		7.62	< 1	521.	< 1	427.	1170	220.	< 0.05	399.	23.	60.0	41.4	2.94	761.
15008011CDC	49.2	77.0	46.4	9.1	200.	2.18	7.97	3.01		7.05	< 1	671.	< 1	550.	1590	404.	< 0.05	817.	48.	100.	11.4	0.75	1070
15008011CDC	54.7	91.0	69.2	11.4	232.	2.68	26.8	3.17		7.08	< 1	661.	< 1	541.	1590	407.	< 0.05	954.	56.	477.	10.9	0.77	1130
15008015DAA	32.6	55.0	56.1	8.0	164.	0.690	15.2	1.49		7.24	< 1	554.	< 1	454.	1260	283.	< 0.05	636.	37.	155.	9.8	0.56	819.
15008023CCC	< 0.1	26.9	25.3	3.4	85.7	0.327	0.325	1.15		7.53	< 1	325	< 1	266	538	32.3	< 0.05	325	19	3.9	0.1	0.00	312
15008023CCC	2.6	25.4	26.6	3.4	81.8	0.418	0.913	1.24		7.59	< 1	325	< 1	266	566	44.9	< 0.05	309	18	13.5	1.8	0.06	322
15008024DCC	0.3	26.4	24.4	3.5	83.9	0.213	4.31	1.36		7.48	< 1	292.	< 1	239.	538.	53.8	< 0.05	318.	19.	32.0	0.2	0.01	315.
15008025CCC	< 0.1	37.3	25.4	3.0	102.	0.470	0.160	4.92		7.46	< 1	331.	< 1	271.	673.	88.9	< 0.05	408.	24.	3.30	0.1	0.00	401.
15008035CBC	9.1	29.6	24.3	3.6	86.8	0.300	4.87	2.16		7.54	< 1	352.	< 1	288.	592.	45.1	0.75	339.	20.	30.0	5.4	0.21	355.
15008036BAA	36.0	33.7	30.9	7.3	92.0	0.869	10.6	1.96		7.49	< 1	374.	< 1	306.	759.	112.	< 0.05	369.	22.	58.0	17.1	0.82	469.
MINIMUM	< 0.1	25.4	21.7	3.0	81.8	0.187	0.160	1.15		7.05	< 1	292.	< 1	239.	538.	32.3	< 0.05	309.	18.	3.30	0.1	0.00	312.
MAXIMUM	135.	91.0	69.2	18.1	232.	2.68	38.8	17.6		7.62	< 1	683.	< 1	559.	1590	407.	0.75	954.	56.	477.	41.4	2.94	1130
MEAN	36.5	48.6	37.6	7.5	118.1	0.848	10.65	3.9	.	7.41	0.5	463	0.5	379	975.1	178	0.07	495	29	105	11.0	0.7	623
MEDIAN	32.6	37.3	26.6	7.3	86.8	0.470	7.23	2.2	.	7.48	0.5	374	0.5	306	759.0	112	0.01	399	23	58	9.8	0.6	469
STDDEV	43.5	25.4	18.7	4.9	57.6	0.892	12.41	5.1	.	0.20	0.0	159	0.0	130	432.6	142	0.25	228	13	148	12.9	0.9	314

All units reported in mg/l except: pH, Conductivity (umhos/cm), Hardness (gr/gal), Turbidity (NTU), % Na (%), and SAR (Sodium Adsorption ration).
CaCO3 is total hardness measured as calcium carbonate.

*** Turtle Lake Aquifer ***

WELL ID (TRSQ)	Na	Mg	SiO2	K	Ca	Mn	Fe	Cl	F	pH	CO3	HCO3	OH	Alk.	Cond.	SO4	NO3	CaCO3	Hard.	Turb.	% Na	SAR	TDS
14708122AAA	175.	40.9	23.3	4.7	80.1	0.173	0.206	10.1		7.65	< 1	591.	< 1	484.	1500	333.	3.11	369.	22.	2.20	50.3	3.96	951.
14708123AAA2	36.8	40.8	62.6	6.1	105.	0.806	14.0	3.74		7.48	< 1	410.	< 1	336.	954.	194.	< 0.05	430.	25.	145.	15.4	0.77	590.
14708124ADD	103.	26.8	43.8	6.4	73.1	0.537	6.80	3.74		7.46	< 1	527.	< 1	432.	1040	148.	< 0.05	293.	17.	78.0	42.5	2.62	623.
14708128ADD	412.	27.5	28.9	8.1	77.9	0.093	8.17	3.92		7.23	< 1	1030	< 1	844.	2000	342.	< 0.05	308.	18.	< 1	73.7	10.2	1380
14708130AAA	134.	45.0	66.1	11.2	131.	0.812	23.5	3.08		7.50	< 1	531.	< 1	435.	1440	308.	< 0.05	513.	30.	190.	35.5	2.57	896.
MINIMUM	36.8	26.8	23.3	4.7	73.1	0.093	0.206	3.08		7.23	< 1	410.	< 1	336.	954.	148.	< 0.05	293.	17.	< 1	15.4	0.77	590.
MAXIMUM	412.	45.0	66.1	11.2	131.	0.812	23.5	10.1		7.65	< 1	1030	< 1	844.	2000	342.	3.11	513.	30.	190.	73.7	10.2	1380
MEAN	172.2	36.2	44.9	7.3	93.4	0.484	10.54	4.9	.	7.46	0.5	618	0.5	506	1386.8	265	0.63	383	22	83	43.5	4.0	888
MEDIAN	134.0	40.8	43.8	6.4	80.1	0.537	8.17	3.7	.	7.48	0.5	531	0.5	435	1440.0	308	0.01	369	22	78	42.5	2.6	896
STDDEV	143.3	8.4	19.3	2.5	24.4	0.340	8.75	2.9	.	0.15	0.0	240	0.0	196	418.1	88	1.39	91	5	85	21.3	3.6	318

All units reported in mg/l except: pH, Conductivity (umhos/cm), Hardness (gr/gal), Turbidity (NTU), % Na (%), and SAR (Sodium Adsorption ration).
CaCO3 is total hardness measured as calcium carbonate.

APPENDIX C

Aquifer Maps Showing Sample Locations

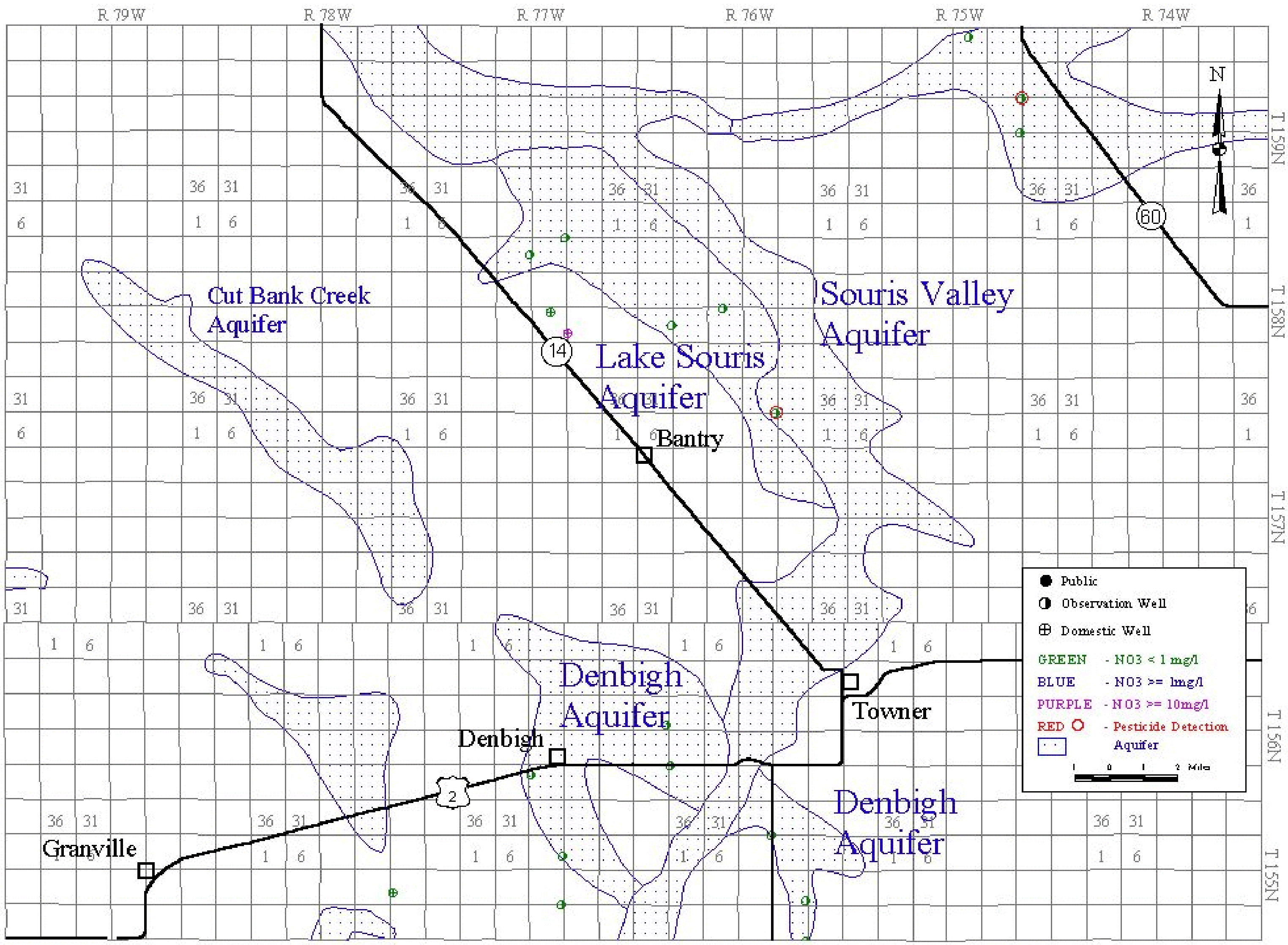


Figure C-1. Sample locations and areal extent for the Denbigh and Lake Souris aquifers

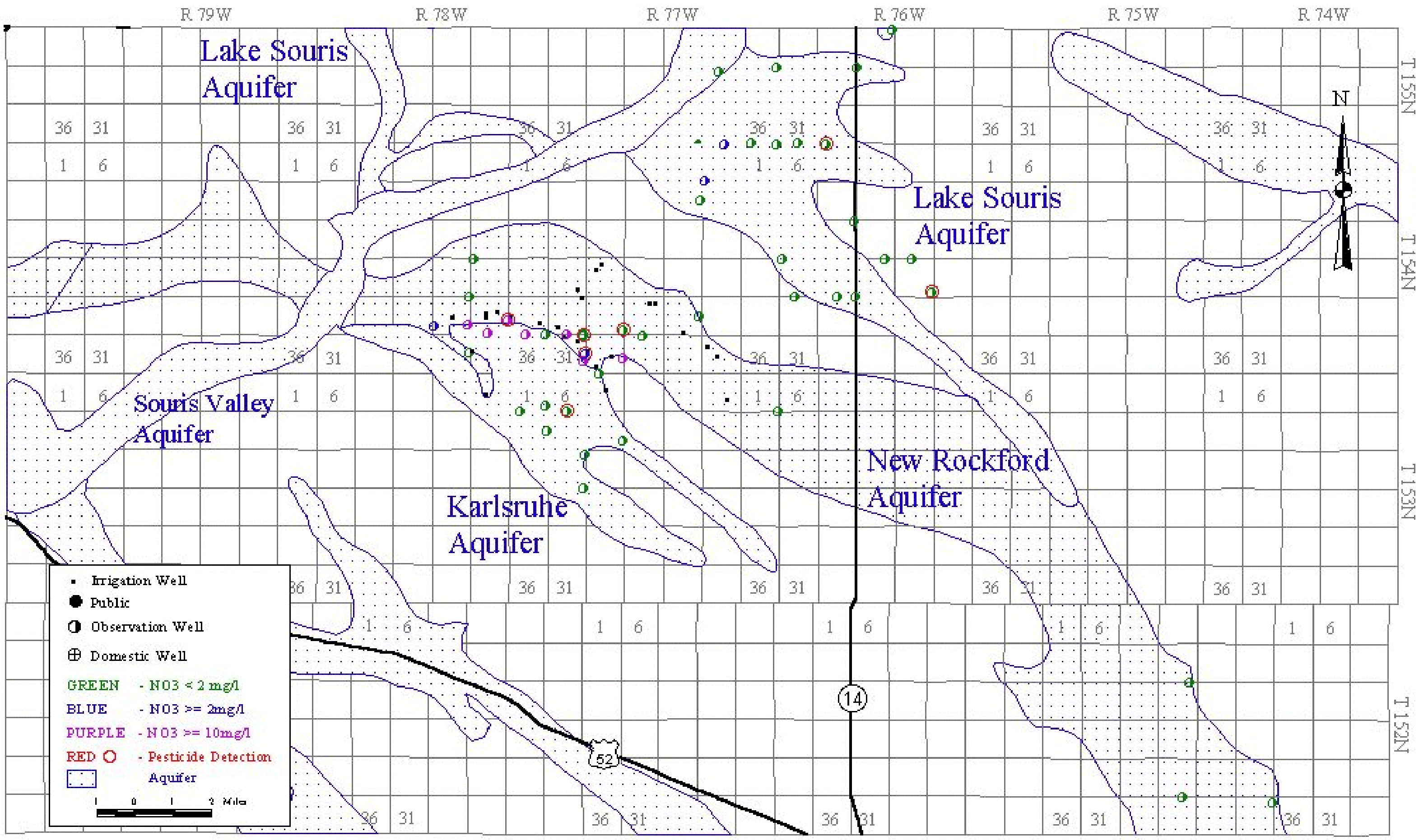


Figure C-2. Sample locations and areal extent for the Karlsruhe, New Rockford and Lake Souris aquifers.

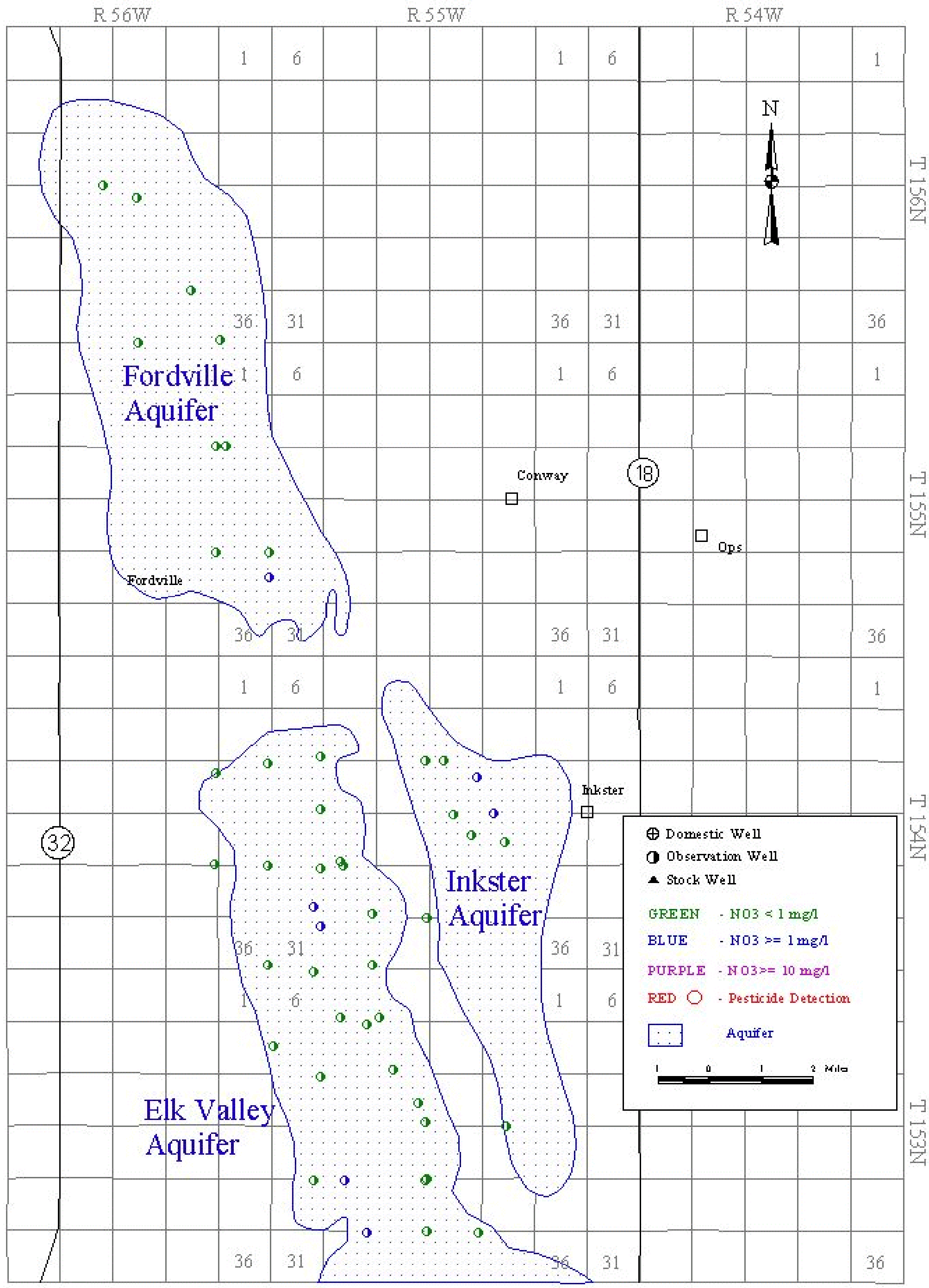


Figure C-3. Sample locations and areal extent for the Fordville, Inkster and northern portion of the Elk Valley aquifers

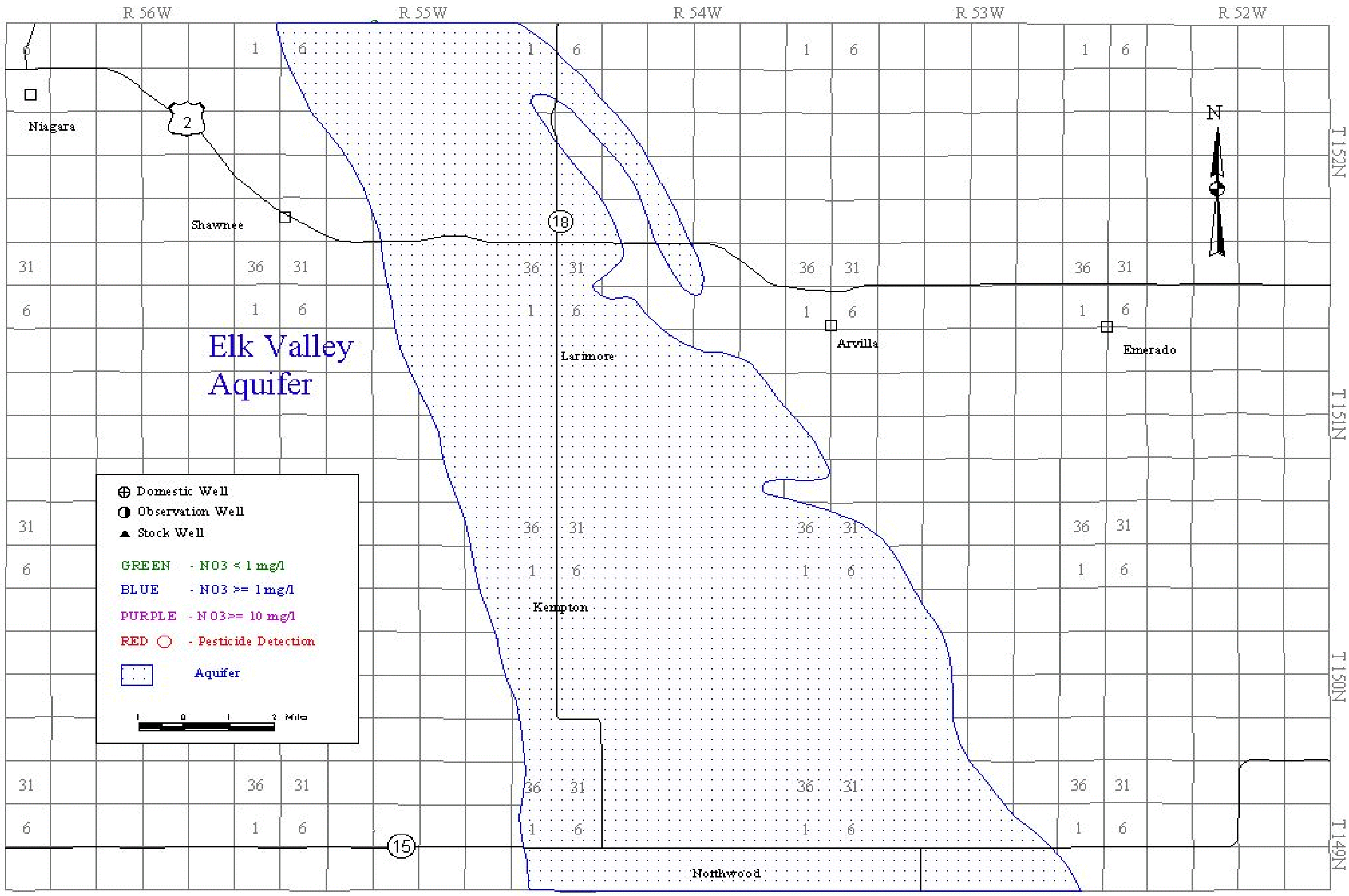


Figure C-4. Sample locations and areal extent for the southern portion of the Elk Valley aquifer

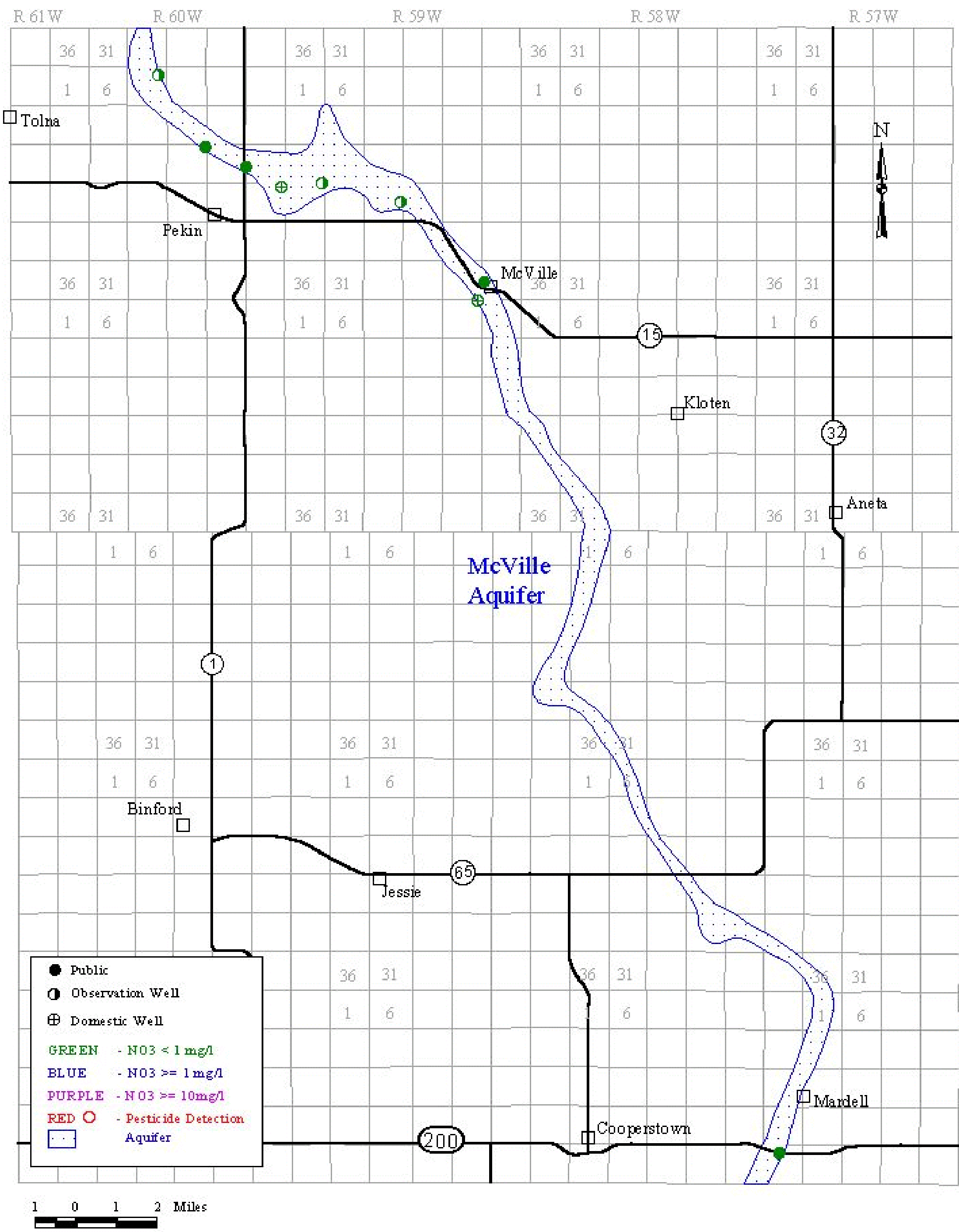


Figure C-5. Sample locations and areal extent for the McVille aquifer

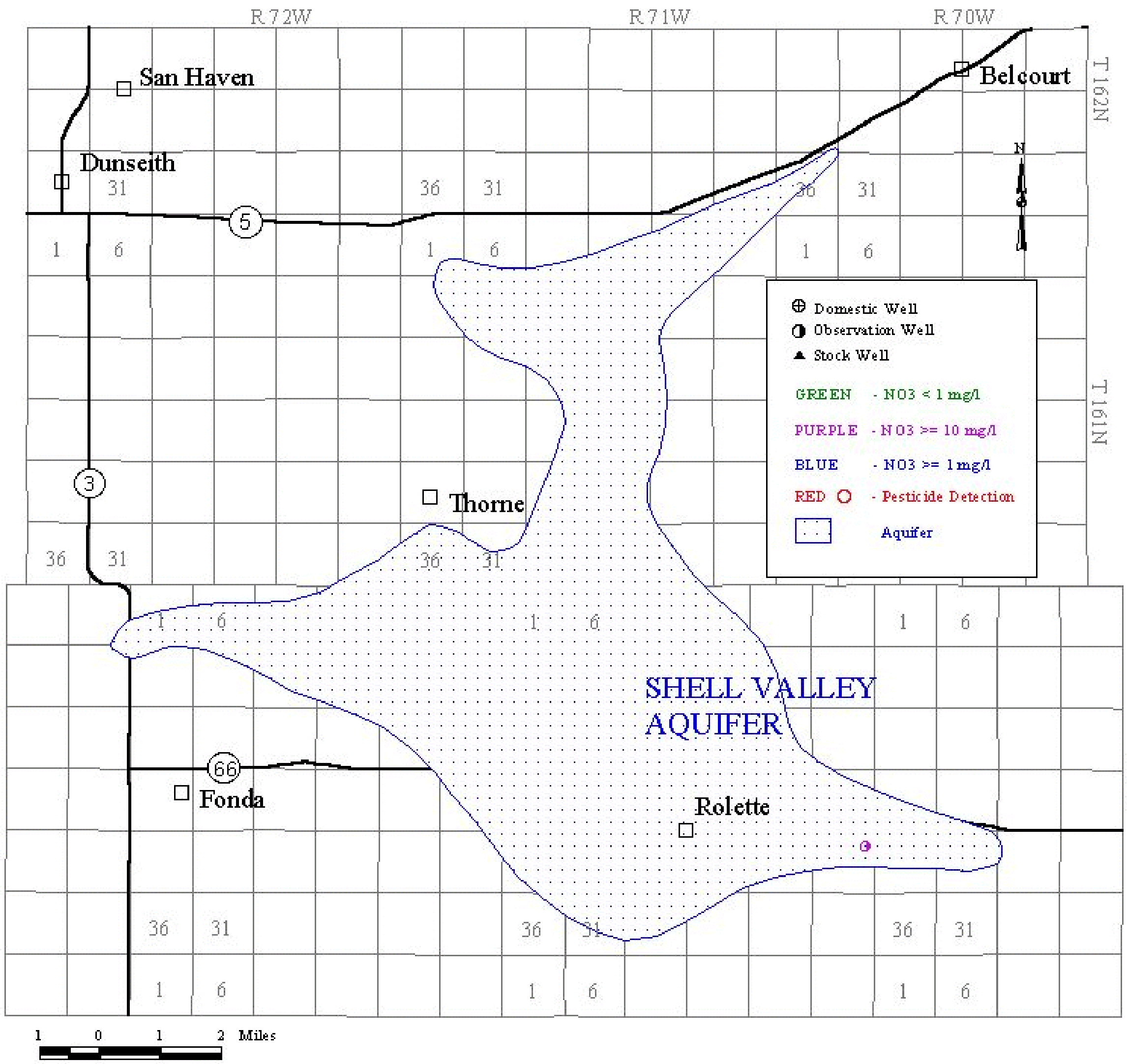


Figure C-6. Sample locations and areal extent for the Shell Valley aquifer

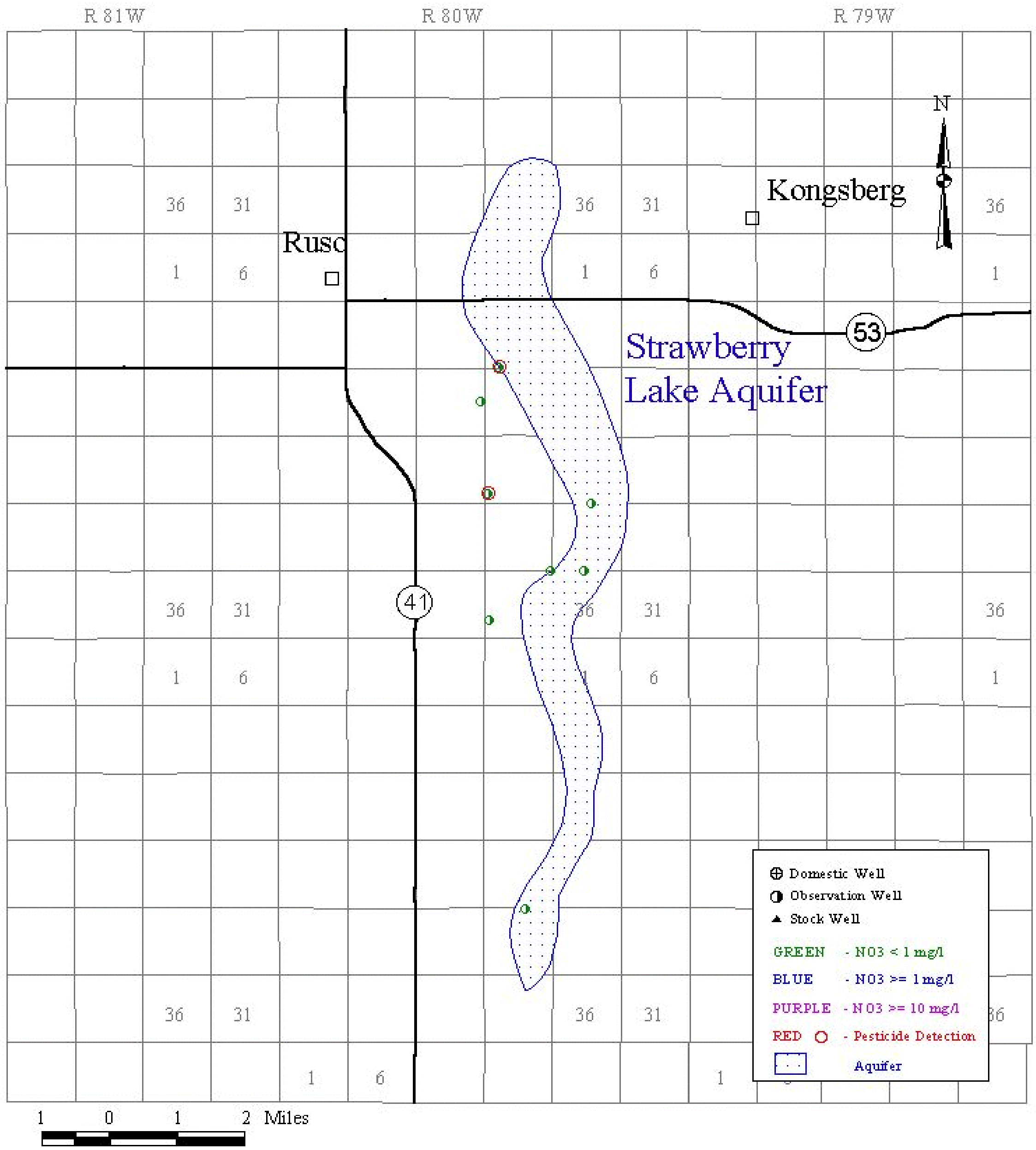


Figure C-7. Sample locations and areal extent for the Strawberry Lake aquifer

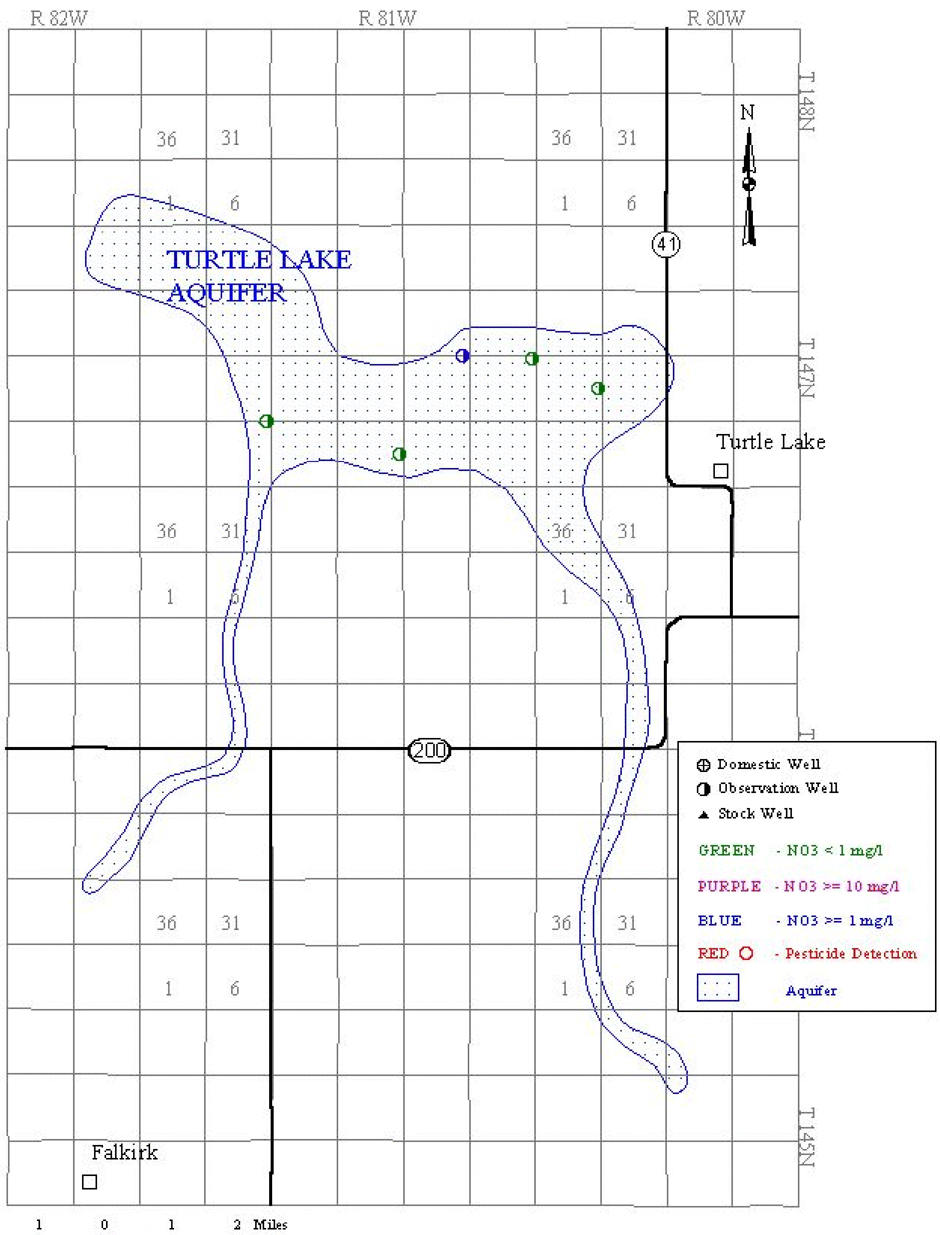


Figure C-8. Sample locations and areal extent for the Turtle Lake aquifer.

APPENDIX D

Summary Tables
for Well-Construction and Site-Survey Characteristics
Related to Pesticide and Nitrate /Nitrite Detections for Each Aquifer

Pesticide and Nitrate Plus Nitrite Detections Related to Well Construction

Denbigh Aquifer

NUMBER OF DETECTIONS		#	PERCENT
Wells with only pesticide detections	:	0	0.0 %
Wells with only nitrate detections	:	0	0.0 %
Wells with pesticide & nitrate detections	:	0	0.0 %
Wells with nitrate > 10 mg/L	:	0	0.0 %

Total number of wells in sample population : 6

DEPTH OF WELLS	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
< 20 Ft. :	0	0.0	0	*****	0	*****
20 - 50 Ft. :	4	66.7	0	0.0	0	0.0
> 50 Ft. :	2	33.3	0	0.0	0	0.0
Unknown :	0	0.0	0	*****	0	*****

DEPTH TO TOP OF SCREENED INTERVAL	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
< 20 Ft. :	1	16.7	0	0.0	0	0.0
20 - 50 Ft. :	4	66.7	0	0.0	0	0.0
> 50 Ft. :	1	16.7	0	0.0	0	0.0
Unknown :	0	0.0	0	*****	0	*****

DIAMETER OF WELL	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
< 6 in. :	6	100.0	0	0.0	0	0.0
6 - 18 in. :	0	0.0	0	*****	0	*****
> 18 in. :	0	0.0	0	*****	0	*****
Unknown :	0	0.0	0	*****	0	*****

DISTANCE FROM WATER TABLE TO TOP OF SCREEN	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
< 10 Ft. :	0	0.0	0	*****	0	*****
10 - 30 Ft. :	4	66.7	0	0.0	0	0.0
> 30 Ft. :	2	33.3	0	0.0	0	0.0
Unknown :	0	0.0	0	*****	0	*****

CASING MATERIAL	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
Plastic(PVC or ABS) :	6	100.0	0	0.0	0	0.0
Concrete/Brick/Stone :	0	0.0	0	*****	0	*****
Metallic :	0	0.0	0	*****	0	*****
Other :	0	0.0	0	*****	0	*****

TYPE OF WELL	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
Monitoring :	6	100.0	0	0.0	0	0.0
Private/Domestic :	0	0.0	0	*****	0	*****
Livestock :	0	0.0	0	*****	0	*****
Public Supply :	0	0.0	0	*****	0	*****
Irrigation :	0	0.0	0	*****	0	*****
Other :	0	0.0	0	*****	0	*****

Pesticide and Nitrate Plus Nitrite Detections Related to Well Construction

Elk Valley Aquifer

NUMBER OF DETECTIONS		#	PERCENT
Wells with only pesticide detections	:	6	7.2 %
Wells with only nitrate detections	:	15	18.1 %
Wells with pesticide & nitrate detections	:	2	2.4 %
Wells with nitrate > 10 mg/L	:	4	4.8 %

Total number of wells in sample population : 83

DEPTH OF WELLS	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
< 20 Ft. :	14	16.9	0	0.0	12	85.7
20 - 50 Ft. :	55	66.3	7	12.7	4	7.3
> 50 Ft. :	12	14.5	1	8.3	0	0.0
Unknown :	2	2.4	0	0.0	1	50.0

DEPTH TO TOP OF SCREENED INTERVAL	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
< 20 Ft. :	19	22.9	0	0.0	14	73.7
20 - 50 Ft. :	55	66.3	8	14.5	2	3.6
> 50 Ft. :	5	6.0	0	0.0	0	0.0
Unknown :	4	4.8	0	0.0	1	25.0

DIAMETER OF WELL	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
< 6 in. :	78	94.0	8	10.3	16	20.5
6 - 18 in. :	2	2.4	0	0.0	0	0.0
> 18 in. :	1	1.2	0	0.0	0	0.0
Unknown :	2	2.4	0	0.0	1	50.0

DISTANCE FROM WATER TABLE TO TOP OF SCREEN	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
< 10 Ft. :	20	24.1	0	0.0	14	70.0
10 - 30 Ft. :	37	44.6	6	16.2	2	5.4
> 30 Ft. :	18	21.7	1	5.6	0	0.0
Unknown :	8	9.6	1	12.5	1	12.5

CASING MATERIAL	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
Plastic(PVC or ABS) :	80	96.4	8	10.0	16	20.0
Concrete/Brick/Stone :	1	1.2	0	0.0	0	0.0
Metallic :	0	0.0	0	*****	0	*****
Other :	2	2.4	0	0.0	1	50.0

TYPE OF WELL	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
Monitoring :	74	89.2	7	9.5	16	21.6
Private/Domestic :	8	9.6	1	12.5	1	12.5
Livestock :	1	1.2	0	0.0	0	0.0
Public Supply :	0	0.0	0	*****	0	*****
Irrigation :	0	0.0	0	*****	0	*****
Other :	0	0.0	0	*****	0	*****

is the number of wells or detections in that category.
% is the percentage of wells or detections in that category.

Pesticide and Nitrate Plus Nitrite Detections
Related to Well Construction
Fordville Aquifer

NUMBER OF DETECTIONS		#	PERCENT
Wells with only pesticide detections	:	1	10.0 %
Wells with only nitrate detections	:	3	30.0 %
Wells with pesticide & nitrate detections	:	0	0.0 %
Wells with nitrate > 10 mg/L	:	0	0.0 %

Total number of wells in sample population : 10

DEPTH OF WELLS	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
< 20 Ft. :	1	10.0	0	0.0	0	0.0
20 - 50 Ft. :	9	90.0	1	11.1	3	33.3
> 50 Ft. :	0	0.0	0	*****	0	*****
Unknown :	0	0.0	0	*****	0	*****

DEPTH TO TOP OF SCREENED INTERVAL	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
< 20 Ft. :	2	20.0	0	0.0	0	0.0
20 - 50 Ft. :	8	80.0	1	12.5	3	37.5
> 50 Ft. :	0	0.0	0	*****	0	*****
Unknown :	0	0.0	0	*****	0	*****

DIAMETER OF WELL	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
< 6 in. :	10	100.0	1	10.0	3	30.0
6 - 18 in. :	0	0.0	0	*****	0	*****
> 18 in. :	0	0.0	0	*****	0	*****
Unknown :	0	0.0	0	*****	0	*****

DISTANCE FROM WATER TABLE TO TOP OF SCREEN	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
< 10 Ft. :	5	50.0	1	20.0	3	60.0
10 - 30 Ft. :	5	50.0	0	0.0	0	0.0
> 30 Ft. :	0	0.0	0	*****	0	*****
Unknown :	0	0.0	0	*****	0	*****

CASING MATERIAL	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
Plastic(PVC or ABS) :	10	100.0	1	10.0	3	30.0
Concrete/Brick/Stone :	0	0.0	0	*****	0	*****
Metallic :	0	0.0	0	*****	0	*****
Other :	0	0.0	0	*****	0	*****

TYPE OF WELL	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
Monitoring :	10	100.0	1	10.0	3	30.0
Private/Domestic :	0	0.0	0	*****	0	*****
Livestock :	0	0.0	0	*****	0	*****
Public Supply :	0	0.0	0	*****	0	*****
Irrigation :	0	0.0	0	*****	0	*****
Other :	0	0.0	0	*****	0	*****

Pesticide and Nitrate Plus Nitrite Detections
Related to Well Construction
Inkster Aquifer

NUMBER OF DETECTIONS		#	PERCENT
Wells with only pesticide detections	:	0	0.0 %
Wells with only nitrate detections	:	2	25.0 %
Wells with pesticide & nitrate detections	:	0	0.0 %
Wells with nitrate > 10 mg/L	:	0	0.0 %

Total number of wells in sample population : 8

DEPTH OF WELLS	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
< 20 Ft. :	1	12.5	0	0.0	1	100.0
20 - 50 Ft. :	6	75.0	0	0.0	1	16.7
> 50 Ft. :	1	12.5	0	0.0	0	0.0
Unknown :	0	0.0	0	*****	0	*****

DEPTH TO TOP OF SCREENED INTERVAL	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
< 20 Ft. :	1	12.5	0	0.0	1	100.0
20 - 50 Ft. :	6	75.0	0	0.0	1	16.7
> 50 Ft. :	1	12.5	0	0.0	0	0.0
Unknown :	0	0.0	0	*****	0	*****

DIAMETER OF WELL	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
< 6 in. :	8	100.0	0	0.0	2	25.0
6 - 18 in. :	0	0.0	0	*****	0	*****
> 18 in. :	0	0.0	0	*****	0	*****
Unknown :	0	0.0	0	*****	0	*****

DISTANCE FROM WATER TABLE TO TOP OF SCREEN	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
< 10 Ft. :	2	25.0	0	0.0	2	100.0
10 - 30 Ft. :	4	50.0	0	0.0	0	0.0
> 30 Ft. :	2	25.0	0	0.0	0	0.0
Unknown :	0	0.0	0	*****	0	*****

CASING MATERIAL	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
Plastic(PVC or ABS) :	8	100.0	0	0.0	2	25.0
Concrete/Brick/Stone :	0	0.0	0	*****	0	*****
Metallic :	0	0.0	0	*****	0	*****
Other :	0	0.0	0	*****	0	*****

TYPE OF WELL	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
Monitoring :	8	100.0	0	0.0	2	25.0
Private/Domestic :	0	0.0	0	*****	0	*****
Livestock :	0	0.0	0	*****	0	*****
Public Supply :	0	0.0	0	*****	0	*****
Irrigation :	0	0.0	0	*****	0	*****
Other :	0	0.0	0	*****	0	*****

is the number of wells or detections in that category.
% is the percentage of wells or detections in that category.

Pesticide and Nitrate Plus Nitrite Detections
Related to Well Construction
Karlsruhe Aquifer

NUMBER OF DETECTIONS		#	PERCENT
Wells with only pesticide detections	:	1	5.3 %
Wells with only nitrate detections	:	9	47.4 %
Wells with pesticide & nitrate detections	:	1	5.3 %
Wells with nitrate > 10 mg/L	:	7	36.8 %

Total number of wells in sample population : 19

DEPTH OF WELLS	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
< 20 Ft. :	4	21.1	1	25.0	1	25.0
20 - 50 Ft. :	14	73.7	0	0.0	8	57.1
> 50 Ft. :	1	5.3	1	100.0	1	100.0
Unknown :	0	0.0	0	*****	0	*****

DEPTH TO TOP OF SCREENED INTERVAL	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
< 20 Ft. :	6	31.6	1	16.7	1	16.7
20 - 50 Ft. :	13	68.4	1	7.7	9	69.2
> 50 Ft. :	0	0.0	0	*****	0	*****
Unknown :	0	0.0	0	*****	0	*****

DIAMETER OF WELL	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
< 6 in. :	19	100.0	2	10.5	10	52.6
6 - 18 in. :	0	0.0	0	*****	0	*****
> 18 in. :	0	0.0	0	*****	0	*****
Unknown :	0	0.0	0	*****	0	*****

DISTANCE FROM WATER TABLE TO TOP OF SCREEN	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
< 10 Ft. :	12	63.2	1	8.3	8	66.7
10 - 30 Ft. :	7	36.8	1	14.3	2	28.6
> 30 Ft. :	0	0.0	0	*****	0	*****
Unknown :	0	0.0	0	*****	0	*****

CASING MATERIAL	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
Plastic(PVC or ABS) :	19	100.0	2	10.5	10	52.6
Concrete/Brick/Stone :	0	0.0	0	*****	0	*****
Metallic :	0	0.0	0	*****	0	*****
Other :	0	0.0	0	*****	0	*****

TYPE OF WELL	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
Monitoring :	19	100.0	2	10.5	10	52.6
Private/Domestic :	0	0.0	0	*****	0	*****
Livestock :	0	0.0	0	*****	0	*****
Public Supply :	0	0.0	0	*****	0	*****
Irrigation :	0	0.0	0	*****	0	*****
Other :	0	0.0	0	*****	0	*****

Pesticide and Nitrate Plus Nitrite Detections
Related to Well Construction
Lake Souris Aquifer

NUMBER OF DETECTIONS		#	PERCENT
Wells with only pesticide detections	:	3	9.1 %
Wells with only nitrate detections	:	7	21.2 %
Wells with pesticide & nitrate detections	:	0	0.0 %
Wells with nitrate > 10 mg/L	:	1	3.0 %

Total number of wells in sample population : 33

DEPTH OF WELLS	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
< 20 Ft. :	4	12.1	0	0.0	1	25.0
20 - 50 Ft. :	23	69.7	3	13.0	7	30.4
> 50 Ft. :	6	18.2	0	0.0	0	0.0
Unknown :	0	0.0	0	*****	0	*****

DEPTH TO TOP OF SCREENED INTERVAL	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
< 20 Ft. :	12	36.4	2	16.7	3	25.0
20 - 50 Ft. :	16	48.5	1	6.3	5	31.3
> 50 Ft. :	5	15.2	0	0.0	0	0.0
Unknown :	0	0.0	0	*****	0	*****

DIAMETER OF WELL	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
< 6 in. :	33	100.0	3	9.1	8	24.2
6 - 18 in. :	0	0.0	0	*****	0	*****
> 18 in. :	0	0.0	0	*****	0	*****
Unknown :	0	0.0	0	*****	0	*****

DISTANCE FROM WATER TABLE TO TOP OF SCREEN	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
< 10 Ft. :	9	27.3	0	0.0	4	44.4
10 - 30 Ft. :	13	39.4	2	15.4	3	23.1
> 30 Ft. :	6	18.2	0	0.0	0	0.0
Unknown :	5	15.2	1	20.0	1	20.0

CASING MATERIAL	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
Plastic(PVC or ABS) :	33	100.0	3	9.1	8	24.2
Concrete/Brick/Stone :	0	0.0	0	*****	0	*****
Metallic :	0	0.0	0	*****	0	*****
Other :	0	0.0	0	*****	0	*****

TYPE OF WELL	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
Monitoring :	29	87.9	3	10.3	7	24.1
Private/Domestic :	3	9.1	0	0.0	1	33.3
Livestock :	1	3.0	0	0.0	0	0.0
Public Supply :	0	0.0	0	*****	0	*****
Irrigation :	0	0.0	0	*****	0	*****
Other :	0	0.0	0	*****	0	*****

is the number of wells or detections in that category.
% is the percentage of wells or detections in that category.

Pesticide and Nitrate Plus Nitrite Detections
Related to Well Construction
McVille Aquifer

NUMBER OF DETECTIONS		#	PERCENT
Wells with only pesticide detections	:	0	0.0 %
Wells with only nitrate detections	:	3	33.3 %
Wells with pesticide & nitrate detections	:	0	0.0 %
Wells with nitrate > 10 mg/L	:	0	0.0 %

Total number of wells in sample population : 9

DEPTH OF WELLS	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
< 20 Ft. :	0	0.0	0	*****	0	*****
20 - 50 Ft. :	1	11.1	0	0.0	0	0.0
> 50 Ft. :	8	88.9	0	0.0	3	37.5
Unknown :	0	0.0	0	*****	0	*****

DEPTH TO TOP OF SCREENED INTERVAL	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
< 20 Ft. :	0	0.0	0	*****	0	*****
20 - 50 Ft. :	1	11.1	0	0.0	0	0.0
> 50 Ft. :	8	88.9	0	0.0	3	37.5
Unknown :	0	0.0	0	*****	0	*****

DIAMETER OF WELL	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
< 6 in. :	5	55.6	0	0.0	1	20.0
6 - 18 in. :	4	44.4	0	0.0	2	50.0
> 18 in. :	0	0.0	0	*****	0	*****
Unknown :	0	0.0	0	*****	0	*****

DISTANCE FROM WATER TABLE TO TOP OF SCREEN	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
< 10 Ft. :	0	0.0	0	*****	0	*****
10 - 30 Ft. :	0	0.0	0	*****	0	*****
> 30 Ft. :	3	33.3	0	0.0	0	0.0
Unknown :	6	66.7	0	0.0	3	50.0

CASING MATERIAL	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
Plastic(PVC or ABS) :	5	55.6	0	0.0	1	20.0
Concrete/Brick/Stone :	0	0.0	0	*****	0	*****
Metallic :	4	44.4	0	0.0	2	50.0
Other :	0	0.0	0	*****	0	*****

TYPE OF WELL	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
Monitoring :	3	33.3	0	0.0	0	0.0
Private/Domestic :	2	22.2	0	0.0	1	50.0
Livestock :	0	0.0	0	*****	0	*****
Public Supply :	4	44.4	0	0.0	2	50.0
Irrigation :	0	0.0	0	*****	0	*****
Other :	0	0.0	0	*****	0	*****

Pesticide and Nitrate Plus Nitrite Detections
Related to Well Construction
New Rockford Aquifer

NUMBER OF DETECTIONS		#	PERCENT
Wells with only pesticide detections	:	2	15.4 %
Wells with only nitrate detections	:	2	15.4 %
Wells with pesticide & nitrate detections	:	1	7.7 %
Wells with nitrate > 10 mg/L	:	2	15.4 %

Total number of wells in sample population : 13

DEPTH OF WELLS	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
< 20 Ft. :	0	0.0	0	*****	0	*****
20 - 50 Ft. :	2	7.7	1	50.0	1	50.0
> 50 Ft. :	11	84.6	2	18.2	1	9.1
Unknown :	0	0.0	0	*****	0	*****

DEPTH TO TOP OF SCREENED INTERVAL	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
< 20 Ft. :	0	0.0	0	*****	0	*****
20 - 50 Ft. :	2	15.4	1	50.0	1	50.0
> 50 Ft. :	11	84.6	2	18.2	1	9.1
Unknown :	0	0.0	0	*****	0	*****

DIAMETER OF WELL	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
< 6 in. :	13	100.0	3	23.1	2	15.4
6 - 18 in. :	0	0.0	0	*****	0	*****
> 18 in. :	0	0.0	0	*****	0	*****
Unknown :	0	0.0	0	*****	0	*****

DISTANCE FROM WATER TABLE TO TOP OF SCREEN	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
< 10 Ft. :	1	7.7	1	100.0	1	100.0
10 - 30 Ft. :	2	15.4	0	0.0	0	0.0
> 30 Ft. :	10	76.9	2	20.0	1	10.0
Unknown :	0	0.0	0	*****	0	*****

CASING MATERIAL	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
Plastic(PVC or ABS) :	12	92.3	2	16.7	1	8.3
Concrete/Brick/Stone :	0	0.0	0	*****	0	*****
Metallic :	1	7.7	1	100.0	1	100.0
Other :	0	0.0	0	*****	0	*****

TYPE OF WELL	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
Monitoring :	13	100.0	3	23.1	2	15.4
Private/Domestic :	0	0.0	0	*****	0	*****
Livestock :	0	0.0	0	*****	0	*****
Public Supply :	0	0.0	0	*****	0	*****
Irrigation :	0	0.0	0	*****	0	*****
Other :	0	0.0	0	*****	0	*****

is the number of wells or detections in that category.
% is the percentage of wells or detections in that category.

Pesticide and Nitrate Plus Nitrite Detections Related to Well Construction
Shell Valley Aquifer

NUMBER OF DETECTIONS		#	PERCENT
Wells with only pesticide detections	:	0	0.0 %
Wells with only nitrate detections	:	4	21.1 %
Wells with pesticide & nitrate detections	:	0	0.0 %
Wells with nitrate > 10 mg/L	:	1	5.3 %

Total number of wells in sample population : 19

DEPTH OF WELLS	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
< 20 Ft. :	0	0.0	0	*****	0	*****
20 - 50 Ft. :	15	78.9	0	0.0	3	20.0
> 50 Ft. :	4	21.1	0	0.0	1	25.0
Unknown :	0	0.0	0	*****	0	*****

DEPTH TO TOP OF SCREENED INTERVAL	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
< 20 Ft. :	3	15.8	0	0.0	1	33.3
20 - 50 Ft. :	14	73.7	0	0.0	2	14.3
> 50 Ft. :	2	10.5	0	0.0	1	50.0
Unknown :	0	0.0	0	*****	0	*****

DIAMETER OF WELL	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
< 6 in. :	19	100.0	0	0.0	4	21.1
6 - 18 in. :	0	0.0	0	*****	0	*****
> 18 in. :	0	0.0	0	*****	0	*****
Unknown :	0	0.0	0	*****	0	*****

DISTANCE FROM WATER TABLE TO TOP OF SCREEN	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
< 10 Ft. :	3	15.8	0	0.0	3	100.0
10 - 30 Ft. :	9	47.4	0	0.0	0	0.0
> 30 Ft. :	6	31.6	0	0.0	1	16.7
Unknown :	1	5.3	0	0.0	0	0.0

CASING MATERIAL	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
Plastic(PVC or ABS) :	18	94.7	0	0.0	3	16.7
Concrete/Brick/Stone :	0	0.0	0	*****	0	*****
Metallic :	1	5.3	0	0.0	1	100.0
Other :	0	0.0	0	*****	0	*****

TYPE OF WELL	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
Monitoring :	18	94.7	0	0.0	4	22.2
Private/Domestic :	1	5.3	0	0.0	0	0.0
Livestock :	0	0.0	0	*****	0	*****
Public Supply :	0	0.0	0	*****	0	*****
Irrigation :	0	0.0	0	*****	0	*****
Other :	0	0.0	0	*****	0	*****

Pesticide and Nitrate Plus Nitrite Detections Related to Well Construction
Strawberry Lake Aquifer

NUMBER OF DETECTIONS		#	PERCENT
Wells with only pesticide detections	:	2	22.2 %
Wells with only nitrate detections	:	1	11.1 %
Wells with pesticide & nitrate detections	:	0	0.0 %
Wells with nitrate > 10 mg/L	:	0	0.0 %

Total number of wells in sample population : 9

DEPTH OF WELLS	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
< 20 Ft. :	0	0.0	0	*****	0	*****
20 - 50 Ft. :	1	11.1	0	0.0	0	0.0
> 50 Ft. :	8	88.9	2	25.0	1	12.5
Unknown :	0	0.0	0	*****	0	*****

DEPTH TO TOP OF SCREENED INTERVAL	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
< 20 Ft. :	0	0.0	0	*****	0	*****
20 - 50 Ft. :	1	11.1	0	0.0	0	0.0
> 50 Ft. :	8	88.9	2	25.0	1	12.5
Unknown :	0	0.0	0	*****	0	*****

DIAMETER OF WELL	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
< 6 in. :	9	100.0	2	22.2	1	11.1
6 - 18 in. :	0	0.0	0	*****	0	*****
> 18 in. :	0	0.0	0	*****	0	*****
Unknown :	0	0.0	0	*****	0	*****

DISTANCE FROM WATER TABLE TO TOP OF SCREEN	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
< 10 Ft. :	0	0.0	0	*****	0	*****
10 - 30 Ft. :	5	55.6	1	20.0	1	20.0
> 30 Ft. :	4	44.4	1	25.0	0	0.0
Unknown :	0	0.0	0	*****	0	*****

CASING MATERIAL	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
Plastic(PVC or ABS) :	9	100.0	2	22.2	1	11.1
Concrete/Brick/Stone :	0	0.0	0	*****	0	*****
Metallic :	0	0.0	0	*****	0	*****
Other :	0	0.0	0	*****	0	*****

TYPE OF WELL	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
Monitoring :	9	100.0	2	22.2	1	11.1
Private/Domestic :	0	0.0	0	*****	0	*****
Livestock :	0	0.0	0	*****	0	*****
Public Supply :	0	0.0	0	*****	0	*****
Irrigation :	0	0.0	0	*****	0	*****
Other :	0	0.0	0	*****	0	*****

is the number of wells or detections in that category.
% is the percentage of wells or detections in that category.

Pesticide and Nitrate Plus Nitrite Detections Related to Well Construction

Turtle Lake Aquifer

NUMBER OF DETECTIONS		#	PERCENT
Wells with only pesticide detections	:	0	0.0 %
Wells with only nitrate detections	:	1	20.0 %
Wells with pesticide & nitrate detections	:	0	0.0 %
Wells with nitrate > 10 mg/L	:	0	0.0 %

Total number of wells in sample population : 5

DEPTH OF WELLS	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
< 20 Ft. :	0	0.0	0	*****	0	*****
20 - 50 Ft. :	2	40.0	0	0.0	1	50.0
> 50 Ft. :	3	60.0	0	0.0	0	0.0
Unknown :	0	0.0	0	*****	0	*****

DEPTH TO TOP OF SCREENED INTERVAL	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
< 20 Ft. :	1	20.0	0	0.0	1	100.0
20 - 50 Ft. :	1	20.0	0	0.0	0	0.0
> 50 Ft. :	3	60.0	0	0.0	0	0.0
Unknown :	0	0.0	0	*****	0	*****

DIAMETER OF WELL	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
< 6 in. :	5	100.0	0	0.0	1	20.0
6 - 18 in. :	0	0.0	0	*****	0	*****
> 18 in. :	0	0.0	0	*****	0	*****
Unknown :	0	0.0	0	*****	0	*****

DISTANCE FROM WATER TABLE TO TOP OF SCREEN	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
< 10 Ft. :	1	20.0	0	0.0	1	100.0
10 - 30 Ft. :	1	20.0	0	0.0	0	0.0
> 30 Ft. :	3	60.0	0	0.0	0	0.0
Unknown :	0	0.0	0	*****	0	*****

CASING MATERIAL	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
Plastic(PVC or ABS) :	5	100.0	0	0.0	1	20.0
Concrete/Brick/Stone :	0	0.0	0	*****	0	*****
Metallic :	0	0.0	0	*****	0	*****
Other :	0	0.0	0	*****	0	*****

TYPE OF WELL	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
Monitoring :	5	100.0	0	0.0	1	20.0
Private/Domestic :	0	0.0	0	*****	0	*****
Livestock :	0	0.0	0	*****	0	*****
Public Supply :	0	0.0	0	*****	0	*****
Irrigation :	0	0.0	0	*****	0	*****
Other :	0	0.0	0	*****	0	*****

is the number of wells or detections in that category.
% is the percentage of wells or detections in that category.

Pesticide and Nitrate Plus Nitrite Detections Related to Site-Inventory Data

Denbigh Aquifer

NUMBER OF DETECTIONS		#	PERCENT
Wells with only pesticide detections	:	0	0.0 %
Wells with only nitrate detections	:	0	0.0 %
Wells with pesticide & nitrate detections	:	0	0.0 %
Wells with nitrate > 10 mg/L	:	0	0.0 %

Total number of wells in sample population : 6

GENERAL SETTING	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
Farm Yard :	0	0.0	0	*****	0	*****
Field :	2	33.3	0	0.0	0	0.0
Pasture :	5	83.3	0	0.0	0	0.0
C.R.P. :	1	16.7	0	0.0	0	0.0
Roadside :	3	50.0	0	0.0	0	0.0
Town :	0	0.0	0	*****	0	*****

NEARBY FACTORS OF POSSIBLE INFLUENCE	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
Near Irrigation :	0	0.0	0	*****	0	*****
Near Feed Lot :	0	0.0	0	*****	0	*****
Near Disposal Area :	0	0.0	0	*****	0	*****
Near Septic System :	0	0.0	0	*****	0	*****
Near Surface Water :	2	33.3	0	0.0	0	0.0
Well in Depression :	0	0.0	0	*****	0	*****
Near Chemical Usage :	0	0.0	0	*****	0	*****
Other :	0	0.0	0	*****	0	*****

NEAR IRRIGATION	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
0 - 100 ft. :	0	0.0	0	*****	0	*****
100 ft. - 1/8 mile :	0	0.0	0	*****	0	*****

NEAR A FEED LOT	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
0 - 100 ft. :	0	0.0	0	*****	0	*****
100 ft. - 1/8 mile :	0	0.0	0	*****	0	*****

NEAR DISPOSAL AREA	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
0 - 100 ft. :	0	0.0	0	*****	0	*****
100 ft. - 1/8 mile :	0	0.0	0	*****	0	*****

NEAR SEPTIC SYSTEM	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
0 - 100 ft. :	0	0.0	0	*****	0	*****
100 ft. - 1/8 mile :	0	0.0	0	*****	0	*****

NEAR SURFACE WATER	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
0 - 100 ft. :	0	0.0	0	*****	0	*****
100 ft. - 1/8 mile :	2	33.3	0	0.0	0	0.0

DEPRESSION AROUND WELL	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
Yes :	0	0.0	0	*****	0	*****
No :	6	100.0	0	0.0	0	0.0
Unknown :	0	0.0	0	*****	0	*****

NEAR CHEMICAL USAGE, MIXING, OR STORAGE	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
Pesticides :	0	0.0	0	*****	0	*****
Fertilizer :	0	0.0	0	*****	0	*****
Petroleum :	0	0.0	0	*****	0	*****
Other :	0	0.0	0	*****	0	*****

NEAR PESTICIDE USAGE, MIXING, OR STORAGE	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
0 - 100 ft. :	0	0.0	0	*****	0	*****
100 ft. - 1/8 mile :	0	0.0	0	*****	0	*****

NEAR FERTILIZER USAGE, MIXING, OR STORAGE	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
0 - 100 ft. :	0	0.0	0	*****	0	*****
100 ft. - 1/8 mile :	0	0.0	0	*****	0	*****

NEAR PETROLEUM STORAGE	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
0 - 100 ft. :	0	0.0	0	*****	0	*****
100 ft. - 1/8 mile :	0	0.0	0	*****	0	*****

CROPS CLOSE TO WELL	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
Small Grains :	0	0.0	0	*****	0	*****
Row Crops :	0	0.0	0	*****	0	*****
Hay :	4	66.7	0	0.0	0	0.0
Pasture :	6	100.0	0	0.0	0	0.0
C.R.P. :	2	33.3	0	0.0	0	0.0

NEAR SMALL GRAIN CROPS	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
0 - 100 ft. :	0	0.0	0	*****	0	*****
100 ft. - 1/8 mile :	0	0.0	0	*****	0	*****

NEAR ROW CROPS	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
0 - 100 ft. :	0	0.0	0	*****	0	*****
100 ft. - 1/8 mile :	0	0.0	0	*****	0	*****

NEAR HAY CROPS	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
0 - 100 ft. :	4	66.7	0	0.0	0	0.0
100 ft. - 1/8 mile :	0	0.0	0	*****	0	*****

NEAR PASTURE	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
0 - 100 ft. :	5	83.3	0	0.0	0	0.0
100 ft. - 1/8 mile :	1	16.7	0	0.0	0	0.0

NEAR C.R.P.	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
0 - 100 ft. :	1	16.7	0	0.0	0	0.0
100 ft. - 1/8 mile :	1	16.7	0	0.0	0	0.0

is the number of wells or detections in that category.
% is the percentage of wells or detections in that category.

Pesticide and Nitrate Plus Nitrite Detections
Related to Site-Inventory Data
Elk Valley Aquifer

NUMBER OF DETECTIONS		#	PERCENT
Wells with only pesticide detections	:	6	7.2 %
Wells with only nitrate detections	:	15	18.1 %
Wells with pesticide & nitrate detections	:	2	2.4 %
Wells with nitrate > 10 mg/L	:	4	4.8 %

Total number of wells in sample population : 83

GENERAL SETTING	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
Farm Yard :	12	14.5	2	16.7	2	16.7
Field :	56	67.5	4	7.1	12	21.4
Pasture :	1	1.2	0	0.0	0	0.0
C.R.P. :	2	2.4	1	50.0	0	0.0
Roadside :	37	44.6	3	8.1	9	24.3
Town :	2	2.4	0	0.0	0	0.0

NEARBY FACTORS OF POSSIBLE INFLUENCE	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
Near Irrigation :	28	33.7	4	14.3	4	14.3
Near Feed Lot :	2	2.4	1	50.0	1	50.0
Near Disposal Area :	0	0.0	0	*****	0	*****
Near Septic System :	12	14.5	2	16.7	3	25.0
Near Surface Water :	12	14.5	2	16.7	1	8.3
Well in Depression :	0	0.0	0	*****	0	*****
Near Chemical Usage :	47	56.6	8	17.0	8	17.0
Other :	9	10.8	2	22.2	1	11.1

NEAR IRRIGATION	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
0 - 100 ft. :	3	3.6	0	0.0	0	0.0
100 ft. - 1/8 mile :	25	30.1	4	16.0	4	16.0

NEAR A FEED LOT	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
0 - 100 ft. :	0	0.0	0	*****	0	*****
100 ft. - 1/8 mile :	2	2.4	1	50.0	1	50.0

NEAR DISPOSAL AREA	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
0 - 100 ft. :	0	0.0	0	*****	0	*****
100 ft. - 1/8 mile :	0	0.0	0	*****	0	*****

NEAR SEPTIC SYSTEM	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
0 - 100 ft. :	2	2.4	0	0.0	0	0.0
100 ft. - 1/8 mile :	10	12.0	2	20.0	3	30.0

NEAR SURFACE WATER	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
0 - 100 ft. :	5	6.0	0	0.0	0	0.0
100 ft. - 1/8 mile :	7	8.4	2	28.6	1	14.3

DEPRESSION AROUND WELL	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
Yes :	0	0.0	0	*****	0	*****
No :	83	100.0	8	9.6	17	20.5
Unknown :	0	0.0	0	*****	0	*****

NEAR CHEMICAL USAGE, MIXING, OR STORAGE	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
Pesticides :	21	25.3	3	14.3	3	14.3
Fertilizer :	17	20.5	2	11.8	2	11.8
Petroleum :	8	9.6	2	25.0	2	25.0
Other :	1	1.2	1	100.0	1	100.0

NEAR PESTICIDE USAGE, MIXING, OR STORAGE	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
0 - 100 ft. :	18	21.7	3	16.7	3	16.7
100 ft. - 1/8 mile :	3	3.6	0	0.0	0	0.0

NEAR FERTILIZER USAGE, MIXING, OR STORAGE	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
0 - 100 ft. :	15	18.1	2	13.3	2	13.3
100 ft. - 1/8 mile :	2	2.4	0	0.0	0	0.0

NEAR PETROLEUM STORAGE	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
0 - 100 ft. :	0	0.0	0	*****	0	*****
100 ft. - 1/8 mile :	8	9.6	2	25.0	2	25.0

CROPS CLOSE TO WELL	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
Small Grains :	65	78.3	5	7.7	12	18.5
Row Crops :	77	92.8	7	9.1	16	20.8
Hay :	8	9.6	1	12.5	1	12.5
Pasture :	4	4.8	0	0.0	1	25.0
C.R.P. :	17	20.5	1	5.9	2	11.8

NEAR SMALL GRAIN CROPS	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
0 - 100 ft. :	58	69.9	5	8.6	11	19.0
100 ft. - 1/8 mile :	7	8.4	0	0.0	1	14.3

NEAR ROW CROPS	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
0 - 100 ft. :	59	71.1	6	10.2	13	22.0
100 ft. - 1/8 mile :	18	21.7	1	5.6	3	16.7

NEAR HAY CROPS	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
0 - 100 ft. :	6	7.2	0	0.0	1	16.7
100 ft. - 1/8 mile :	2	2.4	1	50.0	0	0.0

NEAR PASTURE	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
0 - 100 ft. :	4	4.8	0	0.0	1	25.0
100 ft. - 1/8 mile :	0	0.0	0	*****	0	*****

NEAR C.R.P.	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
0 - 100 ft. :	16	19.3	1	6.3	2	12.5
100 ft. - 1/8 mile :	1	1.2	0	0.0	0	0.0

is the number of wells or detections in that category.
% is the percentage of wells or detections in that category.

Pesticide and Nitrate Plus Nitrite Detections
Related to Site-Inventory Data
Fordville Aquifer

NUMBER OF DETECTIONS		#	PERCENT
Wells with only pesticide detections	:	1	10.0 %
Wells with only nitrate detections	:	3	30.0 %
Wells with pesticide & nitrate detections	:	0	0.0 %
Wells with nitrate > 10 mg/L	:	0	0.0 %

Total number of wells in sample population : 10

GENERAL SETTING	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
Farm Yard :	1	10.0	0	0.0	0	0.0
Field :	8	80.0	1	12.5	3	37.5
Pasture :	0	0.0	0	*****	0	*****
C.R.P. :	2	20.0	0	0.0	1	50.0
Roadside :	9	90.0	1	11.1	2	22.2
Town :	0	0.0	0	*****	0	*****

NEARBY FACTORS OF POSSIBLE INFLUENCE	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
Near Irrigation :	0	0.0	0	*****	0	*****
Near Feed Lot :	0	0.0	0	*****	0	*****
Near Disposal Area :	0	0.0	0	*****	0	*****
Near Septic System :	0	0.0	0	*****	0	*****
Near Surface Water :	2	20.0	1	50.0	0	0.0
Well in Depression :	0	0.0	0	*****	0	*****
Near Chemical Usage :	0	0.0	0	*****	0	*****
Other :	0	0.0	0	*****	0	*****

NEAR IRRIGATION	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
0 - 100 ft. :	0	0.0	0	*****	0	*****
100 ft. - 1/8 mile :	0	0.0	0	*****	0	*****

NEAR A FEED LOT	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
0 - 100 ft. :	0	0.0	0	*****	0	*****
100 ft. - 1/8 mile :	0	0.0	0	*****	0	*****

NEAR DISPOSAL AREA	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
0 - 100 ft. :	0	0.0	0	*****	0	*****
100 ft. - 1/8 mile :	0	0.0	0	*****	0	*****

NEAR SEPTIC SYSTEM	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
0 - 100 ft. :	0	0.0	0	*****	0	*****
100 ft. - 1/8 mile :	0	0.0	0	*****	0	*****

NEAR SURFACE WATER	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
0 - 100 ft. :	0	0.0	0	*****	0	*****
100 ft. - 1/8 mile :	2	20.0	1	50.0	0	0.0

DEPRESSION AROUND WELL	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
Yes :	0	0.0	0	*****	0	*****
No :	10	100.0	1	10.0	3	30.0
Unknown :	0	0.0	0	*****	0	*****

NEAR CHEMICAL USAGE, MIXING, OR STORAGE	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
Pesticides :	0	0.0	0	*****	0	*****
Fertilizer :	0	0.0	0	*****	0	*****
Petroleum :	0	0.0	0	*****	0	*****
Other :	0	0.0	0	*****	0	*****

NEAR PESTICIDE USAGE, MIXING, OR STORAGE	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
0 - 100 ft. :	0	0.0	0	*****	0	*****
100 ft. - 1/8 mile :	0	0.0	0	*****	0	*****

NEAR FERTILIZER USAGE, MIXING, OR STORAGE	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
0 - 100 ft. :	0	0.0	0	*****	0	*****
100 ft. - 1/8 mile :	0	0.0	0	*****	0	*****

NEAR PETROLEUM STORAGE	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
0 - 100 ft. :	0	0.0	0	*****	0	*****
100 ft. - 1/8 mile :	0	0.0	0	*****	0	*****

CROPS CLOSE TO WELL	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
Small Grains :	4	40.0	0	0.0	2	50.0
Row Crops :	5	50.0	0	0.0	2	40.0
Hay :	8	80.0	1	12.5	3	37.5
Pasture :	1	10.0	1	100.0	0	0.0
C.R.P. :	2	20.0	0	0.0	1	50.0

NEAR SMALL GRAIN CROPS	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
0 - 100 ft. :	4	40.0	0	0.0	2	50.0
100 ft. - 1/8 mile :	0	0.0	0	*****	0	*****

NEAR ROW CROPS	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
0 - 100 ft. :	3	30.0	0	0.0	1	33.3
100 ft. - 1/8 mile :	2	20.0	0	0.0	1	50.0

NEAR HAY CROPS	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
0 - 100 ft. :	7	70.0	1	14.3	2	28.6
100 ft. - 1/8 mile :	1	10.0	0	0.0	1	100.0

NEAR PASTURE	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
0 - 100 ft. :	1	10.0	1	100.0	0	0.0
100 ft. - 1/8 mile :	0	0.0	0	*****	0	*****

NEAR C.R.P.	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
0 - 100 ft. :	2	20.0	0	0.0	1	50.0
100 ft. - 1/8 mile :	0	0.0	0	*****	0	*****

is the number of wells or detections in that category.
% is the percentage of wells or detections in that category.

Pesticide and Nitrate Plus Nitrite Detections Related to Site-Inventory Data

Inkster Aquifer

NUMBER OF DETECTIONS		#	PERCENT
Wells with only pesticide detections	:	0	0.0 %
Wells with only nitrate detections	:	2	25.0 %
Wells with pesticide & nitrate detections	:	0	0.0 %
Wells with nitrate > 10 mg/L	:	0	0.0 %

Total number of wells in sample population : 8

GENERAL SETTING	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
Farm Yard :	0	0.0	0	*****	0	*****
Field :	7	87.5	0	0.0	1	14.3
Pasture :	0	0.0	0	*****	0	*****
C.R.P. :	1	12.5	0	0.0	1	100.0
Roadside :	1	12.5	0	0.0	1	100.0
Town :	0	0.0	0	*****	0	*****

NEARBY FACTORS OF POSSIBLE INFLUENCE	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
Near Irrigation :	6	75.0	0	0.0	1	16.7
Near Feed Lot :	0	0.0	0	*****	0	*****
Near Disposal Area :	0	0.0	0	*****	0	*****
Near Septic System :	1	12.5	0	0.0	1	100.0
Near Surface Water :	2	25.0	0	0.0	1	50.0
Well in Depression :	0	0.0	0	*****	0	*****
Near Chemical Usage :	9	112.5	0	0.0	0	0.0
Other :	0	0.0	0	*****	0	*****

NEAR IRRIGATION	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
0 - 100 ft. :	1	12.5	0	0.0	0	0.0
100 ft. - 1/8 mile :	5	62.5	0	0.0	1	20.0

NEAR A FEED LOT	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
0 - 100 ft. :	0	0.0	0	*****	0	*****
100 ft. - 1/8 mile :	0	0.0	0	*****	0	*****

NEAR DISPOSAL AREA	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
0 - 100 ft. :	0	0.0	0	*****	0	*****
100 ft. - 1/8 mile :	0	0.0	0	*****	0	*****

NEAR SEPTIC SYSTEM	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
0 - 100 ft. :	0	0.0	0	*****	0	*****
100 ft. - 1/8 mile :	1	12.5	0	0.0	1	100.0

NEAR SURFACE WATER	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
0 - 100 ft. :	0	0.0	0	*****	0	*****
100 ft. - 1/8 mile :	2	25.0	0	0.0	1	50.0

DEPRESSION AROUND WELL	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
Yes :	0	0.0	0	*****	0	*****
No :	8	100.0	0	0.0	2	25.0
Unknown :	0	0.0	0	*****	0	*****

NEAR CHEMICAL USAGE, MIXING, OR STORAGE	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
Pesticides :	4	50.0	0	0.0	0	0.0
Fertilizer :	4	50.0	0	0.0	0	0.0
Petroleum :	1	12.5	0	0.0	0	0.0
Other :	0	0.0	0	*****	0	*****

NEAR PESTICIDE USAGE, MIXING, OR STORAGE	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
0 - 100 ft. :	2	25.0	0	0.0	0	0.0
100 ft. - 1/8 mile :	2	25.0	0	0.0	0	0.0

NEAR FERTILIZER USAGE, MIXING, OR STORAGE	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
0 - 100 ft. :	2	25.0	0	0.0	0	0.0
100 ft. - 1/8 mile :	2	25.0	0	0.0	0	0.0

NEAR PETROLEUM STORAGE	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
0 - 100 ft. :	0	0.0	0	*****	0	*****
100 ft. - 1/8 mile :	1	12.5	0	0.0	0	0.0

CROPS CLOSE TO WELL	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
Small Grains :	5	62.5	0	0.0	0	0.0
Row Crops :	7	87.5	0	0.0	1	14.3
Hay :	1	12.5	0	0.0	0	0.0
Pasture :	3	37.5	0	0.0	1	33.3
C.R.P. :	3	37.5	0	0.0	2	66.7

NEAR SMALL GRAIN CROPS	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
0 - 100 ft. :	5	62.5	0	0.0	0	0.0
100 ft. - 1/8 mile :	0	0.0	0	*****	0	*****

NEAR ROW CROPS	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
0 - 100 ft. :	4	50.0	0	0.0	1	25.0
100 ft. - 1/8 mile :	3	37.5	0	0.0	0	0.0

NEAR HAY CROPS	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
0 - 100 ft. :	1	12.5	0	0.0	0	0.0
100 ft. - 1/8 mile :	0	0.0	0	*****	0	*****

NEAR PASTURE	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
0 - 100 ft. :	2	25.0	0	0.0	1	50.0
100 ft. - 1/8 mile :	1	12.5	0	0.0	0	0.0

NEAR C.R.P.	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
0 - 100 ft. :	3	37.5	0	0.0	2	66.7
100 ft. - 1/8 mile :	0	0.0	0	*****	0	*****

is the number of wells or detections in that category.
% is the percentage of wells or detections in that category.

Pesticide and Nitrate Plus Nitrite Detections
Related to Site-Inventory Data
Karlsruhe Aquifer

NUMBER OF DETECTIONS	#	PERCENT
Wells with only pesticide detections	1	5.3 %
Wells with only nitrate detections	9	47.4 %
Wells with pesticide & nitrate detections	1	5.3 %
Wells with nitrate > 10 mg/L	7	36.8 %

Total number of wells in sample population : 19

GENERAL SETTING	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
Farm Yard :	0	0.0	0	*****	0	*****
Field :	11	57.9	1	9.1	5	45.5
Pasture :	1	5.3	0	0.0	1	100.0
C.R.P. :	7	36.8	1	14.3	4	57.1
Roadside :	19	100.0	2	10.5	10	52.6
Town :	0	0.0	0	*****	0	*****

NEARBY FACTORS OF POSSIBLE INFLUENCE	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
Near Irrigation :	11	57.9	2	18.2	7	63.6
Near Feed Lot :	1	5.3	0	0.0	1	100.0
Near Disposal Area :	0	0.0	0	*****	0	*****
Near Septic System :	2	10.5	0	0.0	2	100.0
Near Surface Water :	4	21.1	1	25.0	1	25.0
Well in Depression :	0	0.0	0	*****	0	*****
Near Chemical Usage :	7	36.8	0	0.0	5	71.4
Other :	0	0.0	0	*****	0	*****

NEAR IRRIGATION	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
0 - 100 ft. :	6	31.6	2	33.3	4	66.7
100 ft. - 1/8 mile :	5	26.3	0	0.0	3	60.0

NEAR A FEED LOT	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
0 - 100 ft. :	0	0.0	0	*****	0	*****
100 ft. - 1/8 mile :	1	5.3	0	0.0	1	100.0

NEAR DISPOSAL AREA	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
0 - 100 ft. :	0	0.0	0	*****	0	*****
100 ft. - 1/8 mile :	0	0.0	0	*****	0	*****

NEAR SEPTIC SYSTEM	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
0 - 100 ft. :	0	0.0	0	*****	0	*****
100 ft. - 1/8 mile :	2	10.5	0	0.0	2	100.0

NEAR SURFACE WATER	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
0 - 100 ft. :	1	5.3	1	100.0	0	0.0
100 ft. - 1/8 mile :	3	15.8	0	0.0	1	33.3

DEPRESSION AROUND WELL	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
Yes :	0	0.0	0	*****	0	*****
No :	19	100.0	2	10.5	10	52.6
Unknown :	0	0.0	0	*****	0	*****

NEAR CHEMICAL USAGE, MIXING, OR STORAGE	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
Pesticides :	3	15.8	0	0.0	2	66.7
Fertilizer :	3	15.8	0	0.0	2	66.7
Petroleum :	1	5.3	0	0.0	1	100.0
Other :	0	0.0	0	*****	0	*****

NEAR PESTICIDE USAGE, MIXING, OR STORAGE	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
0 - 100 ft. :	1	5.3	0	0.0	1	100.0
100 ft. - 1/8 mile :	2	10.5	0	0.0	1	50.0

NEAR FERTILIZER USAGE, MIXING, OR STORAGE	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
0 - 100 ft. :	0	0.0	0	*****	0	*****
100 ft. - 1/8 mile :	3	15.8	0	0.0	2	66.7

NEAR PETROLEUM STORAGE	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
0 - 100 ft. :	0	0.0	0	*****	0	*****
100 ft. - 1/8 mile :	1	5.3	0	0.0	1	100.0

CROPS CLOSE TO WELL	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
Small Grains :	3	15.8	0	0.0	2	66.7
Row Crops :	13	68.4	2	15.4	8	61.5
Hay :	8	42.1	1	12.5	5	62.5
Pasture :	4	21.1	0	0.0	1	25.0
C.R.P. :	5	26.3	1	20.0	2	40.0

NEAR SMALL GRAIN CROPS	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
0 - 100 ft. :	3	15.8	0	0.0	2	66.7
100 ft. - 1/8 mile :	0	0.0	0	*****	0	*****

NEAR ROW CROPS	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
0 - 100 ft. :	8	42.1	1	12.5	5	62.5
100 ft. - 1/8 mile :	5	26.3	1	20.0	3	60.0

NEAR HAY CROPS	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
0 - 100 ft. :	7	36.8	1	14.3	5	71.4
100 ft. - 1/8 mile :	1	5.3	0	0.0	0	0.0

NEAR PASTURE	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
0 - 100 ft. :	3	15.8	0	0.0	1	33.3
100 ft. - 1/8 mile :	1	5.3	0	0.0	0	0.0

NEAR C.R.P.	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
0 - 100 ft. :	5	26.3	1	20.0	2	40.0
100 ft. - 1/8 mile :	0	0.0	0	*****	0	*****

is the number of wells or detections in that category.
% is the percentage of wells or detections in that category.

Pesticide and Nitrate Plus Nitrite Detections
Related to Site-Inventory Data
Lake Souris Aquifer

NUMBER OF DETECTIONS	#	PERCENT
Wells with only pesticide detections	3	9.1 %
Wells with only nitrate detections	7	21.2 %
Wells with pesticide & nitrate detections	0	0.0 %
Wells with nitrate > 10 mg/L	1	3.0 %

Total number of wells in sample population : 33

GENERAL SETTING	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
Farm Yard :	4	12.1	0	0.0	1	25.0
Field :	11	33.3	1	9.1	4	36.4
Pasture :	22	66.7	3	13.6	4	18.2
C.R.P. :	1	3.0	0	0.0	1	100.0
Roadside :	17	51.5	2	11.8	3	17.6
Town :	0	0.0	0	*****	0	*****

NEARBY FACTORS OF POSSIBLE INFLUENCE	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
Near Irrigation :	5	15.2	0	0.0	5	100.0
Near Feed Lot :	3	9.1	0	0.0	1	33.3
Near Disposal Area :	0	0.0	0	*****	0	*****
Near Septic System :	5	15.2	1	20.0	1	20.0
Near Surface Water :	9	27.3	2	22.2	1	11.1
Well in Depression :	1	3.0	0	0.0	0	0.0
Near Chemical Usage :	2	6.1	0	0.0	1	50.0
Other :	2	6.1	0	0.0	1	50.0

NEAR IRRIGATION	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
0 - 100 ft. :	3	9.1	0	0.0	3	100.0
100 ft. - 1/8 mile :	2	6.1	0	0.0	2	100.0

NEAR A FEED LOT	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
0 - 100 ft. :	2	6.1	0	0.0	1	50.0
100 ft. - 1/8 mile :	1	3.0	0	0.0	0	0.0

NEAR DISPOSAL AREA	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
0 - 100 ft. :	0	0.0	0	*****	0	*****
100 ft. - 1/8 mile :	0	0.0	0	*****	0	*****

NEAR SEPTIC SYSTEM	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
0 - 100 ft. :	1	3.0	0	0.0	0	0.0
100 ft. - 1/8 mile :	4	12.1	1	25.0	1	25.0

NEAR SURFACE WATER	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
0 - 100 ft. :	4	12.1	2	50.0	1	25.0
100 ft. - 1/8 mile :	5	15.2	0	0.0	0	0.0

DEPRESSION AROUND WELL	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
Yes :	1	3.0	0	0.0	0	0.0
No :	32	97.0	3	9.1	8	24.2
Unknown :	0	0.0	0	*****	0	*****

NEAR CHEMICAL USAGE, MIXING, OR STORAGE	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
Pesticides :	1	3.0	0	0.0	0	0.0
Fertilizer :	0	0.0	0	*****	0	*****
Petroleum :	1	3.0	0	0.0	1	100.0
Other :	0	0.0	0	*****	0	*****

NEAR PESTICIDE USAGE, MIXING, OR STORAGE	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
0 - 100 ft. :	0	0.0	0	*****	0	*****
100 ft. - 1/8 mile :	1	3.0	0	0.0	0	0.0

NEAR FERTILIZER USAGE, MIXING, OR STORAGE	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
0 - 100 ft. :	0	0.0	0	*****	0	*****
100 ft. - 1/8 mile :	0	0.0	0	*****	0	*****

NEAR PETROLEUM STORAGE	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
0 - 100 ft. :	1	3.0	0	0.0	1	100.0
100 ft. - 1/8 mile :	0	0.0	0	*****	0	*****

CROPS CLOSE TO WELL	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
Small Grains :	3	9.1	0	0.0	1	33.3
Row Crops :	8	24.2	0	0.0	6	75.0
Hay :	17	51.5	1	5.9	2	11.8
Pasture :	27	81.8	3	11.1	6	22.2
C.R.P. :	5	15.2	1	16.7	3	60.0

NEAR SMALL GRAIN CROPS	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
0 - 100 ft. :	3	9.1	0	0.0	1	33.3
100 ft. - 1/8 mile :	0	0.0	0	*****	0	*****

NEAR ROW CROPS	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
0 - 100 ft. :	5	15.2	0	0.0	4	80.0
100 ft. - 1/8 mile :	3	9.1	0	0.0	2	66.7

NEAR HAY CROPS	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
0 - 100 ft. :	12	36.4	1	8.3	2	16.7
100 ft. - 1/8 mile :	5	15.2	0	0.0	0	0.0

NEAR PASTURE	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
0 - 100 ft. :	24	72.7	3	12.5	5	20.8
100 ft. - 1/8 mile :	3	9.1	0	0.0	1	33.3

NEAR C.R.P.	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
0 - 100 ft. :	4	12.1	0	0.0	2	50.0
100 ft. - 1/8 mile :	1	3.0	1	100.0	1	100.0

is the number of wells or detections in that category.
% is the percentage of wells or detections in that category.

Pesticide and Nitrate Pus Nitrite Detections
Related to Site-Inventory Data
McVille Aquifer

NUMBER OF DETECTIONS		#	PERCENT
Wells with only pesticide detections	:	0	0.0 %
Wells with only nitrate detections	:	3	33.3 %
Wells with pesticide & nitrate detections	:	0	0.0 %
Wells with nitrate > 10 mg/L	:	0	0.0 %

Total number of wells in sample population : 9

GENERAL SETTING	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
Farm Yard :	2	22.2	0	0.0	1	50.0
Field :	6	66.7	0	0.0	3	50.0
Pasture :	2	22.2	0	0.0	0	0.0
C.R.P. :	0	0.0	0	*****	0	*****
Roadside :	7	77.8	0	0.0	2	28.6
Town :	1	11.1	0	0.0	0	0.0

NEARBY FACTORS OF POSSIBLE INFLUENCE	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
Near Irrigation :	0	0.0	0	*****	0	*****
Near Feed Lot :	0	0.0	0	*****	0	*****
Near Disposal Area :	0	0.0	0	*****	0	*****
Near Septic System :	2	22.2	0	0.0	1	50.0
Near Surface Water :	3	33.3	0	0.0	1	33.3
Well in Depression :	0	0.0	0	*****	0	*****
Near Chemical Usage :	1	11.1	0	0.0	1	100.0
Other :	0	0.0	0	*****	0	*****

NEAR IRRIGATION	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
0 - 100 ft. :	0	0.0	0	*****	0	*****
100 ft. - 1/8 mile :	0	0.0	0	*****	0	*****

NEAR A FEED LOT	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
0 - 100 ft. :	0	0.0	0	*****	0	*****
100 ft. - 1/8 mile :	0	0.0	0	*****	0	*****

NEAR DISPOSAL AREA	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
0 - 100 ft. :	0	0.0	0	*****	0	*****
100 ft. - 1/8 mile :	0	0.0	0	*****	0	*****

NEAR SEPTIC SYSTEM	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
0 - 100 ft. :	0	0.0	0	*****	0	*****
100 ft. - 1/8 mile :	2	22.2	0	0.0	1	50.0

NEAR SURFACE WATER	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
0 - 100 ft. :	1	11.1	0	0.0	0	0.0
100 ft. - 1/8 mile :	2	22.2	0	0.0	1	50.0

DEPRESSION AROUND WELL	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
Yes :	0	0.0	0	*****	0	*****
No :	9	100.0	0	0.0	3	33.3
Unknown :	0	0.0	0	*****	0	*****

NEAR CHEMICAL USAGE, MIXING, OR STORAGE	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
Pesticides :	0	0.0	0	*****	0	*****
Fertilizer :	0	0.0	0	*****	0	*****
Petroleum :	1	11.1	0	0.0	1	100.0
Other :	0	0.0	0	*****	0	*****

NEAR PESTICIDE USAGE, MIXING, OR STORAGE	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
0 - 100 ft. :	0	0.0	0	*****	0	*****
100 ft. - 1/8 mile :	0	0.0	0	*****	0	*****

NEAR FERTILIZER USAGE, MIXING, OR STORAGE	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
0 - 100 ft. :	0	0.0	0	*****	0	*****
100 ft. - 1/8 mile :	0	0.0	0	*****	0	*****

NEAR PETROLEUM STORAGE	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
0 - 100 ft. :	1	11.1	0	0.0	1	100.0
100 ft. - 1/8 mile :	0	0.0	0	*****	0	*****

CROPS CLOSE TO WELL	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
Small Grains :	4	44.4	0	0.0	1	25.0
Row Crops :	3	33.3	0	0.0	2	66.7
Hay :	3	33.3	0	0.0	0	0.0
Pasture :	2	22.2	0	0.0	0	0.0
C.R.P. :	3	33.3	0	0.0	1	33.3

NEAR SMALL GRAIN CROPS	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
0 - 100 ft. :	2	22.2	0	0.0	1	50.0
100 ft. - 1/8 mile :	2	22.2	0	0.0	0	0.0

NEAR ROW CROPS	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
0 - 100 ft. :	2	22.2	0	0.0	1	50.0
100 ft. - 1/8 mile :	1	11.1	0	0.0	1	100.0

NEAR HAY CROPS	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
0 - 100 ft. :	3	33.3	0	0.0	0	0.0
100 ft. - 1/8 mile :	0	0.0	0	*****	0	*****

NEAR PASTURE	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
0 - 100 ft. :	2	22.2	0	0.0	0	0.0
100 ft. - 1/8 mile :	0	0.0	0	*****	0	*****

NEAR C.R.P.	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
0 - 100 ft. :	1	11.1	0	0.0	0	0.0
100 ft. - 1/8 mile :	2	22.2	0	0.0	1	50.0

is the number of wells or detections in that category.
% is the percentage of wells or detections in that category.

Pesticide and Nitrate Plus Nitrite Detections
Related to Site-Inventory Data
New Rockford Aquifer

NUMBER OF DETECTIONS		#	PERCENT
Wells with only pesticide detections	:	2	15.4 %
Wells with only nitrate detections	:	2	15.4 %
Wells with pesticide & nitrate detections	:	1	7.7 %
Wells with nitrate > 10 mg/L	:	2	15.4 %

Total number of wells in sample population : 13

GENERAL SETTING	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
Farm Yard :	1	7.7	1	100.0	0	0.0
Field :	11	84.6	2	18.2	2	18.2
Pasture :	2	15.4	1	50.0	0	0.0
C.R.P. :	1	7.7	0	0.0	0	0.0
Roadside :	11	84.6	2	20.0	2	20.0
Town :	0	0.0	0	*****	0	*****

NEARBY FACTORS OF POSSIBLE INFLUENCE	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
Near Irrigation :	5	38.5	2	40.0	2	40.0
Near Feed Lot :	0	0.0	0	*****	0	*****
Near Disposal Area :	0	0.0	0	*****	0	*****
Near Septic System :	0	0.0	0	*****	0	*****
Near Surface Water :	0	0.0	0	*****	0	*****
Well in Depression :	1	7.7	0	0.0	0	0.0
Near Chemical Usage :	4	30.8	3	75.0	3	75.0
Other :	1	7.7	1	100.0	1	100.0

NEAR IRRIGATION	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
0 - 100 ft. :	2	15.4	1	50.0	2	100.0
100 ft. - 1/8 mile :	3	23.1	1	33.3	0	0.0

NEAR A FEED LOT	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
0 - 100 ft. :	0	0.0	0	*****	0	*****
100 ft. - 1/8 mile :	0	0.0	0	*****	0	*****

NEAR DISPOSAL AREA	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
0 - 100 ft. :	0	0.0	0	*****	0	*****
100 ft. - 1/8 mile :	0	0.0	0	*****	0	*****

NEAR SEPTIC SYSTEM	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
0 - 100 ft. :	0	0.0	0	*****	0	*****
100 ft. - 1/8 mile :	0	0.0	0	*****	0	*****

NEAR SURFACE WATER	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
0 - 100 ft. :	0	0.0	0	*****	0	*****
100 ft. - 1/8 mile :	0	0.0	0	*****	0	*****

DEPRESSION AROUND WELL	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
Yes :	1	7.7	0	0.0	0	0.0
No :	12	92.3	3	25.0	2	16.7
Unknown :	0	0.0	0	*****	0	*****

NEAR CHEMICAL USAGE, MIXING, OR STORAGE	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
Pesticides :	1	7.7	1	100.0	1	100.0
Fertilizer :	1	7.7	1	100.0	1	100.0
Petroleum :	2	15.4	2	100.0	1	50.0
Other :	0	0.0	0	*****	0	*****

NEAR PESTICIDE USAGE, MIXING, OR STORAGE	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
0 - 100 ft. :	1	7.7	1	100.0	1	100.0
100 ft. - 1/8 mile :	0	0.0	0	*****	0	*****

NEAR FERTILIZER USAGE, MIXING, OR STORAGE	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
0 - 100 ft. :	1	7.7	1	100.0	1	100.0
100 ft. - 1/8 mile :	0	0.0	0	*****	0	*****

NEAR PETROLEUM STORAGE	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
0 - 100 ft. :	1	7.7	1	100.0	1	100.0
100 ft. - 1/8 mile :	1	7.7	1	100.0	0	0.0

CROPS CLOSE TO WELL	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
Small Grains :	6	46.2	1	16.7	0	0.0
Row Crops :	7	53.8	2	28.6	2	28.6
Hay :	5	38.5	1	20.0	0	0.0
Pasture :	6	46.2	2	33.3	0	0.0
C.R.P. :	6	46.2	2	33.3	2	33.3

NEAR SMALL GRAIN CROPS	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
0 - 100 ft. :	4	30.8	0	0.0	0	0.0
100 ft. - 1/8 mile :	2	15.4	1	50.0	0	0.0

NEAR ROW CROPS	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
0 - 100 ft. :	4	30.8	1	25.0	2	50.0
100 ft. - 1/8 mile :	3	23.1	1	50.0	0	0.0

NEAR HAY CROPS	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
0 - 100 ft. :	5	38.5	1	20.0	0	0.0
100 ft. - 1/8 mile :	0	0.0	0	*****	0	*****

NEAR PASTURE	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
0 - 100 ft. :	3	23.1	1	33.3	0	0.0
100 ft. - 1/8 mile :	3	23.1	1	33.3	0	0.0

NEAR C.R.P.	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
0 - 100 ft. :	3	23.1	0	0.0	1	33.3
100 ft. - 1/8 mile :	3	23.1	2	66.7	1	33.3

is the number of wells or detections in that category.
% is the percentage of wells or detections in that category.

Pesticide and Nitrate Plus Nitrite Detections
Related to Site-Inventory Data
Shell Valley Aquifer

NUMBER OF DETECTIONS		#	PERCENT
Wells with only pesticide detections	:	0	0.0 %
Wells with only nitrate detections	:	4	21.1 %
Wells with pesticide & nitrate detections	:	0	0.0 %
Wells with nitrate > 10 mg/L	:	1	5.3 %

Total number of wells in sample population : 19

GENERAL SETTING	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
Farm Yard :	0	0.0	0	*****	0	*****
Field :	11	57.9	0	0.0	2	18.2
Pasture :	5	26.3	0	0.0	2	40.0
C.R.P. :	3	15.8	0	0.0	1	33.3
Roadside :	12	63.2	0	0.0	1	8.3
Town :	0	0.0	0	*****	0	*****

NEARBY FACTORS OF POSSIBLE INFLUENCE	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
Near Irrigation :	1	5.3	0	0.0	0	0.0
Near Feed Lot :	1	5.3	0	0.0	0	0.0
Near Disposal Area :	0	0.0	0	*****	0	*****
Near Septic System :	2	10.5	0	0.0	1	50.0
Near Surface Water :	8	42.1	0	0.0	1	12.5
Well in Depression :	0	0.0	0	*****	0	*****
Near Chemical Usage :	2	10.5	0	0.0	1	50.0
Other :	0	0.0	0	*****	0	*****

NEAR IRRIGATION	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
0 - 100 ft. :	1	5.3	0	0.0	0	0.0
100 ft. - 1/8 mile :	0	0.0	0	*****	0	*****

NEAR A FEED LOT	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
0 - 100 ft. :	1	5.3	0	0.0	0	0.0
100 ft. - 1/8 mile :	0	0.0	0	*****	0	*****

NEAR DISPOSAL AREA	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
0 - 100 ft. :	0	0.0	0	*****	0	*****
100 ft. - 1/8 mile :	0	0.0	0	*****	0	*****

NEAR SEPTIC SYSTEM	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
0 - 100 ft. :	1	5.3	0	0.0	0	0.0
100 ft. - 1/8 mile :	1	5.3	0	0.0	1	100.0

NEAR SURFACE WATER	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
0 - 100 ft. :	5	26.3	0	0.0	1	20.0
100 ft. - 1/8 mile :	3	15.8	0	0.0	0	0.0

DEPRESSION AROUND WELL	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
Yes :	0	0.0	0	*****	0	*****
No :	19	100.0	0	0.0	4	21.1
Unknown :	0	0.0	0	*****	0	*****

NEAR CHEMICAL USAGE, MIXING, OR STORAGE	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
Pesticides :	1	5.3	0	0.0	1	100.0
Fertilizer :	0	0.0	0	*****	0	*****
Petroleum :	1	5.3	0	0.0	0	0.0
Other :	0	0.0	0	*****	0	*****

NEAR PESTICIDE USAGE, MIXING, OR STORAGE	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
0 - 100 ft. :	1	5.3	0	0.0	1	100.0
100 ft. - 1/8 mile :	0	0.0	0	*****	0	*****

NEAR FERTILIZER USAGE, MIXING, OR STORAGE	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
0 - 100 ft. :	0	0.0	0	*****	0	*****
100 ft. - 1/8 mile :	0	0.0	0	*****	0	*****

NEAR PETROLEUM STORAGE	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
0 - 100 ft. :	1	5.3	0	0.0	0	0.0
100 ft. - 1/8 mile :	0	0.0	0	*****	0	*****

CROPS CLOSE TO WELL	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
Small Grains :	8	42.1	0	0.0	2	25.0
Row Crops :	2	10.5	0	0.0	1	50.0
Hay :	9	47.4	0	0.0	2	22.2
Pasture :	12	63.2	0	0.0	2	16.7
C.R.P. :	6	31.6	0	0.0	2	33.3

NEAR SMALL GRAIN CROPS	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
0 - 100 ft. :	8	42.1	0	0.0	2	25.0
100 ft. - 1/8 mile :	0	0.0	0	*****	0	*****

NEAR ROW CROPS	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
0 - 100 ft. :	1	5.3	0	0.0	1	100.0
100 ft. - 1/8 mile :	1	5.3	0	0.0	0	0.0

NEAR HAY CROPS	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
0 - 100 ft. :	9	47.4	0	0.0	2	22.2
100 ft. - 1/8 mile :	0	0.0	0	*****	0	*****

NEAR PASTURE	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
0 - 100 ft. :	9	47.4	0	0.0	2	22.2
100 ft. - 1/8 mile :	3	15.8	0	0.0	0	0.0

NEAR C.R.P.	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
0 - 100 ft. :	5	26.3	0	0.0	2	40.0
100 ft. - 1/8 mile :	1	5.3	0	0.0	0	0.0

is the number of wells or detections in that category.
% is the percentage of wells or detections in that category.

Pesticide and Nitrate Plus Nitrite Detections Related to Site-Inventory Data

Strawberry Lake Aquifer

NUMBER OF DETECTIONS		#	PERCENT
Wells with only pesticide detections	:	2	22.2 %
Wells with only nitrate detections	:	1	11.1 %
Wells with pesticide & nitrate detections	:	0	0.0 %
Wells with nitrate > 10 mg/L	:	0	0.0 %

Total number of wells in sample population : 9

GENERAL SETTING	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
Farm Yard :	0	0.0	0	*****	0	*****
Field :	5	55.6	1	20.0	1	20.0
Pasture :	4	44.4	1	25.0	0	0.0
C.R.P. :	4	44.4	1	25.0	0	0.0
Roadside :	5	55.6	1	20.0	1	20.0
Town :	0	0.0	0	*****	0	*****

NEARBY FACTORS OF POSSIBLE INFLUENCE	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
Near Irrigation :	0	0.0	0	*****	0	*****
Near Feed Lot :	0	0.0	0	*****	0	*****
Near Disposal Area :	0	0.0	0	*****	0	*****
Near Septic System :	0	0.0	0	*****	0	*****
Near Surface Water :	5	55.6	2	40.0	0	0.0
Well in Depression :	0	0.0	0	*****	0	*****
Near Chemical Usage :	0	0.0	0	*****	0	*****
Other :	0	0.0	0	*****	0	*****

NEAR IRRIGATION	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
0 - 100 ft. :	0	0.0	0	*****	0	*****
100 ft. - 1/8 mile :	0	0.0	0	*****	0	*****

NEAR A FEED LOT	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
0 - 100 ft. :	0	0.0	0	*****	0	*****
100 ft. - 1/8 mile :	0	0.0	0	*****	0	*****

NEAR DISPOSAL AREA	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
0 - 100 ft. :	0	0.0	0	*****	0	*****
100 ft. - 1/8 mile :	0	0.0	0	*****	0	*****

NEAR SEPTIC SYSTEM	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
0 - 100 ft. :	0	0.0	0	*****	0	*****
100 ft. - 1/8 mile :	0	0.0	0	*****	0	*****

NEAR SURFACE WATER	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
0 - 100 ft. :	0	0.0	0	*****	0	*****
100 ft. - 1/8 mile :	5	55.6	2	40.0	0	0.0

DEPRESSION AROUND WELL	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
Yes :	0	0.0	0	*****	0	*****
No :	9	100.0	2	22.2	1	11.1
Unknown :	0	0.0	0	*****	0	*****

NEAR CHEMICAL USAGE, MIXING, OR STORAGE	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
Pesticides :	0	0.0	0	*****	0	*****
Fertilizer :	0	0.0	0	*****	0	*****
Petroleum :	0	0.0	0	*****	0	*****
Other :	0	0.0	0	*****	0	*****

NEAR PESTICIDE USAGE, MIXING, OR STORAGE	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
0 - 100 ft. :	0	0.0	0	*****	0	*****
100 ft. - 1/8 mile :	0	0.0	0	*****	0	*****

NEAR FERTILIZER USAGE, MIXING, OR STORAGE	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
0 - 100 ft. :	0	0.0	0	*****	0	*****
100 ft. - 1/8 mile :	0	0.0	0	*****	0	*****

NEAR PETROLEUM STORAGE	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
0 - 100 ft. :	0	0.0	0	*****	0	*****
100 ft. - 1/8 mile :	0	0.0	0	*****	0	*****

CROPS CLOSE TO WELL	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
Small Grains :	5	55.6	1	20.0	0	0.0
Row Crops :	0	0.0	0	*****	0	*****
Hay :	4	44.4	1	25.0	1	25.0
Pasture :	7	77.8	2	28.6	1	14.3
C.R.P. :	5	55.6	1	20.0	0	0.0

NEAR SMALL GRAIN CROPS	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
0 - 100 ft. :	3	33.3	1	33.3	0	0.0
100 ft. - 1/8 mile :	2	22.2	0	0.0	0	0.0

NEAR ROW CROPS	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
0 - 100 ft. :	0	0.0	0	*****	0	*****
100 ft. - 1/8 mile :	0	0.0	0	*****	0	*****

NEAR HAY CROPS	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
0 - 100 ft. :	3	33.3	1	33.3	1	33.3
100 ft. - 1/8 mile :	1	11.1	0	0.0	0	0.0

NEAR PASTURE	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
0 - 100 ft. :	6	66.7	1	16.7	1	16.7
100 ft. - 1/8 mile :	1	11.1	1	100.0	0	00.0

NEAR C.R.P.	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
0 - 100 ft. :	3	33.3	1	33.3	0	0.0
100 ft. - 1/8 mile :	2	22.2	0	0.0	0	0.0

is the number of wells or detections in that category.
% is the percentage of wells or detections in that category.

Pesticide and Nitrate Plus Nitrite Detections Related to Site-Inventory Data

Turtle Lake Aquifer

NUMBER OF DETECTIONS		#	PERCENT
Wells with only pesticide detections	:	0	0.0 %
Wells with only nitrate detections	:	1	20.0 %
Wells with pesticide & nitrate detections	:	0	0.0 %
Wells with nitrate > 10 mg/L	:	0	0.0 %

Total number of wells in sample population : 5

GENERAL SETTING	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
Farm Yard :	0	0.0	0	*****	0	*****
Field :	3	60.0	0	0.0	0	0.0
Pasture :	3	60.0	0	0.0	1	33.3
C.R.P. :	0	0.0	0	*****	0	*****
Roadside :	4	80.0	0	0.0	1	25.0
Town :	0	0.0	0	*****	0	*****

NEARBY FACTORS OF POSSIBLE INFLUENCE	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
Near Irrigation :	1	20.0	0	0.0	1	100.0
Near Feed Lot :	0	0.0	0	*****	0	*****
Near Disposal Area :	0	0.0	0	*****	0	*****
Near Septic System :	0	0.0	0	*****	0	*****
Near Surface Water :	3	60.0	0	0.0	1	33.3
Well in Depression :	0	0.0	0	*****	0	*****
Near Chemical Usage :	0	0.0	0	*****	0	*****
Other :	0	0.0	0	*****	0	*****

NEAR IRRIGATION	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
0 - 100 ft. :	0	0.0	0	*****	0	*****
100 ft. - 1/8 mile :	1	20.0	0	0.0	1	100.0

NEAR A FEED LOT	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
0 - 100 ft. :	0	0.0	0	*****	0	*****
100 ft. - 1/8 mile :	0	0.0	0	*****	0	*****

NEAR DISPOSAL AREA	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
0 - 100 ft. :	0	0.0	0	*****	0	*****
100 ft. - 1/8 mile :	0	0.0	0	*****	0	*****

NEAR SEPTIC SYSTEM	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
0 - 100 ft. :	0	0.0	0	*****	0	*****
100 ft. - 1/8 mile :	0	0.0	0	*****	0	*****

NEAR SURFACE WATER	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
0 - 100 ft. :	0	0.0	0	*****	0	*****
100 ft. - 1/8 mile :	3	60.0	0	0.0	1	33.3

DEPRESSION AROUND WELL	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
Yes :	0	0.0	0	*****	0	*****
No :	5	100.0	0	0.0	1	20.0
Unknown :	0	0.0	0	*****	0	*****

NEAR CHEMICAL USAGE, MIXING, OR STORAGE	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
Pesticides :	0	0.0	0	*****	0	*****
Fertilizer :	0	0.0	0	*****	0	*****
Petroleum :	0	0.0	0	*****	0	*****
Other :	0	0.0	0	*****	0	*****

NEAR PESTICIDE USAGE, MIXING, OR STORAGE	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
0 - 100 ft. :	0	0.0	0	*****	0	*****
100 ft. - 1/8 mile :	0	0.0	0	*****	0	*****

NEAR FERTILIZER USAGE, MIXING, OR STORAGE	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
0 - 100 ft. :	0	0.0	0	*****	0	*****
100 ft. - 1/8 mile :	0	0.0	0	*****	0	*****

NEAR PETROLEUM STORAGE	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
0 - 100 ft. :	0	0.0	0	*****	0	*****
100 ft. - 1/8 mile :	0	0.0	0	*****	0	*****

CROPS CLOSE TO WELL	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
Small Grains :	3	60.0	0	0.0	1	33.3
Row Crops :	2	40.0	0	0.0	1	50.0
Hay :	1	20.0	0	0.0	0	0.0
Pasture :	3	60.0	0	0.0	1	33.3
C.R.P. :	0	0.0	0	*****	0	*****

NEAR SMALL GRAIN CROPS	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
0 - 100 ft. :	3	60.0	0	0.0	1	33.3
100 ft. - 1/8 mile :	0	0.0	0	*****	0	*****

NEAR ROW CROPS	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
0 - 100 ft. :	1	20.0	0	0.0	0	0.0
100 ft. - 1/8 mile :	1	20.0	0	0.0	1	100.0

NEAR HAY CROPS	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
0 - 100 ft. :	1	20.0	0	0.0	0	0.0
100 ft. - 1/8 mile :	0	0.0	0	*****	0	*****

NEAR PASTURE	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
0 - 100 ft. :	3	60.0	0	0.0	1	33.3
100 ft. - 1/8 mile :	0	0.0	0	*****	0	*****

NEAR C.R.P.	#	%	# PEST. DET.	% PEST. DET.	# NO3 DET.	% NO3 DET.
0 - 100 ft. :	0	0.0	0	*****	0	*****
100 ft. - 1/8 mile :	0	0.0	0	*****	0	*****

is the number of wells or detections in that category.
% is the percentage of wells or detections in that category.

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APPENDIX E

Health Advisories

HEALTH ADVISORIES

The Health Advisory Program, sponsored by EPA's Office of Drinking Water, provides information about the health effects, analytical methodology and treatment technology that would be useful in dealing with contamination of water resources. Health advisories describe nonregulatory concentrations of drinking water contaminants called Health Advisory Levels (HALs), at which adverse health effects would not be anticipated to occur over specific exposure durations. HALs contain a margin of safety to protect sensitive members of the population. Health advisories serve as informal technical guidelines to assist in protecting public health. They are not to be construed as legally enforceable federal standards. The HALs are subject to change as new information becomes available.

The Safe Drinking Water Act has specified Maximum Contaminant Levels (MCLs) for a variety of organic and inorganic constituents. MCLs are enforceable for public water systems, but are not enforceable for private or individual water systems. HALs and MCLs do not address other beneficial uses of water, such as irrigation or discharge to surface water.

The development of HALs and MCLs is based on essentially the same criteria. HALs are developed for one-day, ten-day, longer-term (approximately seven years or 10 percent of an individual's lifetime), and lifetime exposures. The Lifetime Exposure HAL includes a factor to account for exposure to the contaminant from sources other than drinking water. An MCL is essentially the same as a Lifetime Exposure HAL.

Seven pesticides or pesticide degradation products, as well as nitrate plus nitrite, were detected in samples collected for this study. A summary of health advisory information for these contaminants follows. All information included is from EPA, Office of Drinking Water, health advisory bulletins; the *Farm Chemicals Handbook '97*; the *Handbook of Environmental Data on Organic Chemicals*; the *Merck Index*; the *International Union of Pure and Applied Chemistry (IUPAC)*; and *Pesticide Use and Pest Management Practices for Major Crops in North Dakota, 1996.*

Bentazon

Common names: Common trade names for bentazon are Basagran, Bendioxide and Bentazone.

Chemical formula: The empirical chemical formula for bentazon is $C_{10}H_{12}N_2O_3S$. Its composition is 3-(1methylethyl)-1H-2,1,3-benzothiadiazin-4(3H)-one,2,2-dioxide (IUPAC).

Physical properties: At room temperature, bentazon is a crystalline powder that has no odor or color. It has a solubility of 500 mg/l and a melting point in the range of 137 degrees to 139 degrees C. The retail formulation is a soluble concentrate.

Uses and occurrence: Bentazon is a selective herbicide that controls a number of broadleaf and sedge weeds. It is used primarily in most gramineous and many large-seeded leguminous crops. In 1996, bentazon was applied to approximately 577,300 acres in North Dakota (Zollinger et al., 1998).

Environmental fate: Bentazon is a very mobile chemical in soil and water. It is hydrolyzed poorly and undergoes photodecomposition very slowly, but is degraded rapidly by bacteria and fungi. The speed of degradation is decreased by decreasing temperature. The half-life of bentazon under these conditions is less than one month.

Health effects: Small doses of bentazon are almost completely absorbed when ingested by mammals. It is not metabolized significantly in the body; however, small traces of two unidentified metabolites have been detected. Approximately 92 percent of the ingested bentazon passes through the body and is excreted. No information about the health effects of this chemical in the human body was available. The LD_{50} for various species of animals, however, ranged from approximately 500 to 1100 mg/kg. No valid data was available to make a determination of the carcinogenic potential of bentazon. Because of this, bentazon has been included in Group D: Not Classifiable. This group is generally used for substances with inadequate or no human and animal evidence of carcinogenicity.

Health advisory level: The lifetime HAL for bentazon has been set at 0.02 mg/l (20 μg/l or 20 ppb).

Treatment technologies: No information was available about treatment technologies used to effectively remove bentazon from contaminated water.

2,4-Dichlorophenoxyacetic Acid (2,4-D)

Common names: Trade names for 2,4-D are 2,4-D; Amoxone; Aqua-Kleen; Chloroxone; and Weed-B-Gone.

Chemical formula: The empirical chemical formula for 2,4-D is $C_8H_6O_3Cl_2$. The composition for 2,4-D is 2,4-dichlorophenoxyacetic acid (IUPAC).

Physical properties: 2,4-D is a white crystalline powder. The melting point of 2,4-D is 140.5 degrees C. It is only slightly soluble in water (540 mg/l) and petroleum distillate; however, it is soluble in organic solvents and alcohols. The acid is not used customarily by itself, but usually as an amine, salt or ester. The esters are soluble in oils, and the amine salts are soluble in water. Retail formulations include the emulsion form (esters); aqueous solutions (salts); and amines, of which the amine in largest production is the dimethylamine salt. As with amines that form salts with the 2,4-D acid, esters are made with a wide variety of alcohols.

Uses and occurrence: 2,4-D is a selective, systemic herbicide widely used in North Dakota to control broadleaf weeds in wheat, barley, oats, flax, corn, sunglowers, soybeans, dry beans, potatoes, alfalfa and other hay, pasture, summer fallow and CRP. 2,4-D is the most widely used herbicide in North Dakota -- in 1996, it was applied, alone, to 7,907,100 acres, or 19.1 percent of the agricultural acres in the state. In conjunction with other chemicals, it was applied to an additional 1,425,000 acres (Zollinger et al., 1998).

Environmental fate: 2,4-D is degraded in the environment and is not considered to be a persistent compound. It is metabolized by plants, is readily degraded by soil bacteria, and undergoes hydrolysis under environmental conditions. The half-life of 2,4-D is reported to be from one to six weeks in soil. Once in the soil, 2,4-D and some of its salts and esters have been demonstrated to migrate. 2,4-D does not tend to accumulate in soils and reportedly does not bioaccumulate in plants and animals. Many broadleaf crops are extremely sensitive to 2,4-D.

Health effects: 2,4-D is absorbed almost completely after ingestion. 2,4-D acid is distributed into the blood, liver, kidney, heart, lungs and spleen, with lower levels occurring in the muscles and brain. The data indicate that 2,4-D does not undergo biotransformation to any great extent. A male agricultural student who ingested at least six grams of a commercial herbicide preparation of the dimethyl amine salt of 2,4-D died after vomiting and convulsions. Pathological examination showed degenerative ganglion cell changes in the brain. Occupational exposure to 2,4-D has resulted in reduced nerve conduction velocities. Case-controlled epidemiological studies of populations in Scandinavian countries exposed to the phenoxy herbicides indicate excess risk of the development of soft-tissue sarcomas and malignant lymphomas. Acute oral LD_{50} values of approximately 350 to 1000 mg/kg of 2,4-D acid have been reported for small mammals. An LD_{50} of 100 mg/kg in dogs was reported. 2,4-D is classified in Group D: Not Classifiable. This category is for agents with inadequate or no human and animal evidence of carcinogenicity.

Health advisory level: The MCL and the lifetime HAL for 2,4-D have been set at 0.07 mg/l (70μg/l or 70 ppb).

Treatment technologies: Treatment technologies capable of removing 2,4-D from drinking water are adsorption by granular or powdered carbon and reverse osmosis.

Endrin

Common names: Endrex and Hexadrin.

Chemical formula: The empirical chemical formula for endrin is $C_{12}H_8Cl_6O$. Its composition is 3,4,5,6,9,9-Hexachloro-1a,2,2a,3,6,6a,7,-7a-octahydro-2,7:3,6-dimethanonaphth[2,3-b]oxirene; 1,2,3-4,10,10-hexachloro-6,7-epoxy-1,4,4a,5,6,7,8,8a-octahydro-endo,endo-1,4:5,8-dimethanonaphthalene.

Physical properties: Endrin is a colorless, crystalline solid. The crystals decompose, or melt, at 245 degrees C. Endrin has a water solubility of 0.24 mg/l at 25 degrees C. Retail formulations include emulsifiable concentrate, wettable powder and dust.

Uses and occurrence: Endrin is an insecticide once widely used in the United States. In 1979, the U.S. EPA canceled the use of endrin for a number of uses, and registration for new uses of endrin was denied. Endrin is presently registered only for the control of cutworms, grasshoppers and moles. The manufacture of endrin was discontinued in 1987 by Shell International Chemical Co., Ltd.

Environmental fate: Endrin is considered to be a persistent compound. Endrin is biodegraded poorly, and, once in the ground, endrin rapidly binds onto soils and migrates slowly. Endrin has the potential to bioaccumulate.

Health effects: Endrin is a central nervous system depressant and hepatotoxin. There is no antidote for endrin poisoning. Endrin is distributed in the fat, liver, brain and kidneys of mammals (both animal and human) and is metabolized rapidly. Endrin residues decline rapidly after cessation of exposure; however, both wild and domestic birds store endrin in various body tissues, especially fat. Exposure to endrin may cause sudden convulsions, headache, dizziness, sleepiness, weakness, nausea, vomiting, insomnia, agitation, mental confusion and loss of appetite. A number of deaths have occurred from swallowing endrin. Cases of fatal endrin poisoning have been reported from intentional and accidental ingestion. The time periods from administration of the pesticide to death ranged from one to six months. Endrin ingestion with milk or alcohol appeared to increase toxicity, as death occurred within an hour or two, possibly due to more rapid absorption through the gastrointestinal tract. An oral LD_{50} value of 7 to 15 mg/kg has been reported in rats. Endrin is classified in Group D: Not Classifiable. This category is used for substances with inadequate or no human and animal evidence of carcinogenicity.

Health advisory level: The MCL and lifetime HAL for endrin have been set at 0.002 mg/l (2 μg/l or 2 ppb).

Treatment technologies: Treatment technologies capable of removing endrin from drinking water include adsorption by activated carbon -- both granular and powdered – air stripping, reverse osmosis and coagulation/filtration.

3-Hydroxycarbofuran

Common names: Common trade names for carbofuran are Furadan, Amifuran, Futura, Curaterr, Furasun, Carboter, Vegfru Diafuran, Furasul, Carbodan and Yaltox.

Chemical formula: The empirical chemical formula for carbofuran is $C_{12}H_{15}NO_3$. The composition is 2,3-dihydro-2,2-dimethyl-7-benzofuranyl methylcarbamate (CAS).

Physical Characteristics: Carbofuran is a white crystalline solid, with a melting point of 153 degrees to 154 degrees C. Formulations include granular, flowable, wettable powder and flowable concentrate for seed treatments.

Use and occurrence: Carbofuran is a broad spectrum insecticide, nematocide and miticide used on soil and foliar pests such as aphids, lygus bugs, alfalfa weevils, rice water weevils, corn rootworms, nematodes, potato beetles, leafhoppers, flea beetles, grasshoppers, chinch bugs, greenbugs, stem weevils and sunflower beetles.

Environmental fate: Carbofuran is degraded by chemical hydrolysis and microbial action. The major metabolites of carbofuran degradation in soil are 3-hydroxycarbofuran, 3-ketocarbofuran and carbofuran phenol. Technical carbofuran has a half-life in soil (pH 6.5) of between 11 and 13 days, and the granular formulation has a half-life of 60 to70 days. It hydrolyzes in water (pH 7) at 25 degrees C in 8.2 weeks. Chemical hydrolysis and degradation in soils occur much more rapidly under alkaline conditions. Photodecomposition and volatilization of carbofuran from soil are of little significance in dissipation of the chemical in soil and aquatic conditions.

Health effects: The EPA issued a ban on carbofuran granular formulations in 1994 because bird kills were occurring from ingesting the granules. There is no ban on the liquid formulation, but it has been classified as a Restricted Use Pesticide because of its acute oral and inhalation toxicity to humans. Some symptoms of carbofuran poisoning include nausea, vomiting, abdominal cramps, sweating and difficulty breathing. Death may result at high doses from respiratory system failure. The oral LD_{50} in rats is 5 to 13 mg/kg. Carbofuran is not a carcinogen, but it does affect the nervous system.

Health advisory level: The MCL for carbofuran has been set at 0.04 mg/l (40 μg/l or 40 ppb).

Treatment technologies: No information was available about treatment technologies to effectively remove carbofuran from water.

Methomyl

Common names: Common trade names for methomyl are Acinate, Memilene L, Lanox, Lannate and Agrinate.

Chemical formula: The empirical chemical formula for methomyl is $C_5H_{10}N_2O_2S$. The composition is S-methyl N-[(methylcarbamoyl)oxy)]thioacetimidate (CAS 8CI).

Physical properties: Methomyl is a colorless or white crystalline solid at 25 degrees C. It has a melting point of 78 degrees to 79 degrees C, and a solubility in water of 5.8 g/100 g. Formulations include liquid, low volatility liquid and water-soluble powder.

Uses and occurrence: Methomyl is an insecticide used as a foliar treatment to control a broad spectrum of insects in vegetables, soybeans, corn, cotton, other field crops, certain fruit crops and ornamentals.

Environmental fate: Microbial degradation is the primary transformation process of methomyl in soil, with CO_2 being the major end product . The half-life of methomyl in soil is about three to six days, and the hydrolysis half-life in water with a ph of 7 is approximately 38 weeks.

Health effects: Methomyl may be fatal if swallowed and poisonous if inhaled. Lethal doses have been estimated in rats, with oral LD_{50} values of 17 mg/kg (male) and 24 mg/kg (female). Lethal concentrations have been estimated in fish, with LC_{50} values of 3.4 mg/l (96 h) (rainbow trout) and 0.8 mg/l (bluegill).

Health advisory level: The HAL for methomyl has been set at 0.2 mg/l (200 μg/l or 200 ppb).

Treatment technologies: Activated carbon will effectively remove methomyl from drinking water.

Picloram

Common names: The most common trade name for picloram is Tordon. Other trade names include Amdon, ACTP, Borolin and K-Pin.

Chemical formula: The empirical chemical formula for picloram is $C_6H_3Cl_3N_2O_2$. The structural formula is 4-amino-3,5,6-trichloropicolinic acid.

Physical properties: At room temperature picloram is a white powder. At 215 degrees C, picloram decomposes before it melts. It has a solubility of 430 mg/l at 20 degrees C, with a slight chlorine-like odor. Retail formulations include water-soluble liquid and granules.

Uses and occurrence: Picloram is used as a broad-spectrum herbicide for the control of broadleafed and woody plants in rangelands, pastures, small grains and rights-of-way for power lines and roadways. In 1996 it was applied to approximately 280,600 acres in North Dakota (Zollinger et al., 1998).

Environmental fate: The main processes for dissipation of picloram in the environment are photodegradation and aerobic soil degradation. Photodegradation occurs rapidly in water but somewhat slower on a soil surface. Hydrolysis of picloram is very slow. Laboratory studies have shown that under aerobic soil conditions, the half-life of picloram is dependent upon the applied concentration and the temperature and moisture of the soil. Field tests have indicated that picloram's half-life varies from about one month to several months. Following normal agricultural, forestry or industrial applications, long-term accumulation of picloram in the soil generally does not occur. Under anaerobic conditions picloram has been shown to be quite stable, with very little degradation.

Health effects: Picloram is readily absorbed by mammals through the gastrointestinal tract. It is not metabolized significantly in the body, however, and 90 percent to 95 percent passes through the body within about two days. The acute oral toxicity of picloram is low. Lethal doses have been estimated in a number of species, with LD_{50} values ranging from 2,000 to 4,000 mg/kg. In a study of mice there was no indication of a carcinogenic response from dietary exposure. A rat study was negative for carcinogenic effects in males; however, females exhibited an increase in neoplastic nodules. Picloram has been included in Group D: Not Classified. This group is generally used for substances with inadequate human and animal evidence of carcinogenicity or for which no data are available.

Health advisory level: The MCL for picloram has been set at 0.5 mg/l (500 ug/l or 500 ppb).

Treatment technologies: No information was found about treatment technologies capable of effectively removing picloram from drinking water.

Triallate

Common names: Common trade names for Triallate are Far-go, Avadex BW, Buckle, Carbamothoic acid, CP 23426, Dipthal, Showdown and TDTC Technical.

Chemical Formula: The composition for triallate is S-2,3,3-trichloroallyl di-isopropyl(thiocarbamate).

Physical properties: Triallate is an amber, oily liquid. It has a melting point of 29 degrees to 30 degrees C, and a solubility in water of 4 mg/l at 25 degrees C. Formulations include an emulsifiable concentrate and granular.

Uses and occurrence: Triallate is a herbicide used to control wild oats in barley, green peas, field dried peas, chickpeas, garbanzo beans, lentils, triticale and wheat. Application is preemergent emulsifiable concentrate and granular applied to the soil.

Environmental fate: Triallate has moderate persistence in the soil environment. It adsorbs strongly to clay and loam soils and is not readily dissolved by water. Degradation occurs primarily by microbial action in the soil. Plants also can degrade Triallate, and if not incorporated into the soil, it can be lost by volatilization. The half-life of Triallate in soil is approximately 82 days.

Health effects: Triallate is slightly toxic by ingestion and practically nontoxic via dermal exposure or inhalation. The oral LD_{50} for technical triallate in rats is 800 to 2165 mg/kg, and in mice, 930 mg/kg. The oral LD_{50} in rats for emulsifiable concentrate formulations is 2700 mg/kg, and for granular formulations is greater than 12,000 mg/kg. In general, triallate is rapidly absorbed into the bloodstream from the gastrointestinal tract, readily broken down into metabolites, and then excreted by treated animals. It is rarely possible to detect thiocarbamates in the blood. A single oral dose of 500 mg/kg of triallate rapidly was absorbed from the gastrointestinal tract of rabbits. It was then found to be present in all organs tested within 15 to 20 minutes after dosing. The largest amount of the herbicide accumulated in the liver, lungs, kidneys and spleen. All traces were gone by the seventh day. Triallate is not considered a carcinogen, but it has been shown to cause reproductive problems in high doses.

Health advisory level: There currently is no MCL or HAL for triallate

Treatment technologies: Activated carbon will effectively remove triallate from drinking water.

Nitrate and Nitrite

Chemical formula: NO_3 and NO_2

Uses and occurrence: The major use of nitrate and nitrite is in inorganic fertilizers. They also may be derived from septic systems, feedlots or areas with heavy manure loading, or from the decomposition of other organic materials. Nitrates and nitrites also are used extensively in the manufacture of explosives and in the curing of meats. The North Dakota Agricultural Statistics Service (1991) reported that 729,355 gross tons of fertilizer were applied in North Dakota in 1990, with 278,086 tons of that being nitrogen nutrient content. By comparison, 1,332,778 gross tons of fertilizer were applied in 1997, with 594,686 tons of that being nitrogen nutrient content (North Dakota Agricultural Statistics Service, 1998).

Environmental fate: Nitrates and nitrites in groundwater have been shown to degrade or dissipate with depth in an aquifer. The rates vary widely, depending upon temperature and other factors.

The exact processes are not completely understood. Because nitrite is easily oxidized to form nitrate, nitrate predominates in groundwater. Nitrate and nitrite ions are very mobile in soil and groundwater.

Health effects: Ingestion of nitrates and nitrites has resulted in a condition known as methemoglobinemia, which is sometimes referred to as "blue baby syndrome." Methemoglobinemia is caused by the reaction of nitrite (not nitrate) with red blood cells to form methemoglobin, which does not carry oxygen as normal hemoglobin does. This may result in anoxemia and cyanosis and, in severe cases, may be fatal.

While nitrate is readily excreted by the kidneys and is not directly metabolized in the human body, it is metabolized by bacteria in humans. In adults, high acidity levels in the gastrointestinal tract limit the number of nitrate-reducing bacteria; however, the lower gastrointestinal acidity levels in infants allow greater numbers of these bacteria to survive. These bacteria convert nitrate into nitrite, which is absorbed by the bloodstream. The oxygen starvation condition resulting from high concentrations of methemoglobin in the bloodstream will cause an infant's skin to have a bluish color. This is the reason methemoglobinemia is sometimes called blue baby syndrome. As an infant grows older, numbers of nitrate-reducing bacteria decrease, as do chances for developing methemoglobinemia.

Health advisory level: Nitrate is toxic because it can be converted to nitrite and the total toxicity of the two is additive. Therefore, nitrate and nitrite cannot be considered independently. The MCL for nitrite in drinking water is 1.0 mg/l as nitrogen. The MCL for nitrate is 10.0 mg/l (N), as is the MCL for total nitrate plus nitrite (N). These levels have been set to protect infants. Adults can safely ingest greater concentrations than this, and ruminant animals (cattle, sheep, etc.) can normally consume concentrations up to 100.0 mg/l.

Treatment technologies: Methods to remove nitrate from drinking water include distillation and reverse osmosis.

APPENDIX F

List of Abbreviations and Acronyms

CAS	Chemical Abstracts Service
DC	Division of Chemistry
EERC	Environmental Energy and Research Center
EPA	Environmental Protection Agency
HAL	health advisory level
IUPAC	International Union of Pure and Applied Chemistry
MCL	maximum contaminant level
mg/l	milligrams per liter, equivalent to ppm or 1000 μg/l (liquid volume measurement)
N	(as) nitrogen
NDDoH	North Dakota Department of Health
NO_3	nitrate plus nitrite
ppb	parts per billion
ppm	parts per million
QA/QC	Quality Assurance/Quality Control
μg/l	micrograms per liter, equivalent to ppb or 0.001 mg/l (liquid volume measurement)
μmhos/cm	micromhos per centimeter